THE

ELECTRICAL REVIEW.

VOL. XXXII. MAY 26, 1893. No. 809

CONTENTS:

	PAGE
"Cheap Traction or Defective Telephones"	609
Electricity in the Treatment of Cancer	610
Electric Street Lighting in Munich	613
The Cost of Private Electric Supply	613
Some Notes on the Design of Series Motors for Traction (*cont.*) (*illustrated*)	615
Electric Cooking and the Load Factor	617
Modern Gas and Oil Engines	618
Electricity in Agriculture	619
Railway Accidents	619
Train Lighting in Australia (*illustrated*)	621
The Reduction of the Refractory Earths by Means of the Electric Furnace	622
Test of 100-H.P. Gas Engine	623
Cheap Traction or Defective Telephones	624
Tests of a Castle Dynamo and Willans Engine (*illustrated*) ...	625
Relation of Volta E.M.F. to Pressure, &c.	626
Notes	627
Contracts Open and Closed	631
Business Notices, &c.	631
City Notes, &c.:—The Telphone Company of Ireland	632
Traffic Receipts	632
Share List of Electrical Companies	633
Telegraphic Communication in the West Indies (*continued*) ...	634
Cable Soundings in the Pacific	635
Proceedings of Societies:—	
The Institution of Electrical Engineers (*illustrated*)	635
Glasgow Philosophical Society	637
Société Internationale des Electriciens	638
New Patents	638
Abstracts of Published Specifications	639
Correspondence:—Electric Heating	639
Paralleling of Alternators	640
Railway Train Lighting	640
Facts and Figures on Electrolytic Chlorine and Soda ...	640

J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893.

ORDER AT ONCE.

PRICE 4/- POST FREE.
The **Leading Electrical Trades Directory** *and the Oldest Electrical Directory in the World.*

ONLY A FEW COPIES REMAIN IN STOCK. WE SHALL NOT REPRINT THIS ISSUE.

PRICE 4/- POST FREE.
Fully Revised and Thoroughly Reliable.
Contains a larger amount of commercial Trade Matter than any other Electrical Directory.

H. ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established **1872.**

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address "AGNEKAY, LONDON." Code A B C. Telephone No. 517

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free, per Year, 19s. 6d. To all *Foreign Countries* (except those mentioned below), per Year, £1 1s. 6d. *Exceptions.*—Abyssinia, Aden, Borneo, Ceylon, India, Java, Labuan, Mozambique, Penang, Persia (*viâ* Brindisi), Phillipine Islands, Singapore, Zanzibar, to which the rates are: per Year, £1 8s. 10d.

BINDING.—Subscribers' numbers bound, including case, for 2s. 6d. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—*New York:* D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 23, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 22, Paternoster Row E.C.

"CHEAP TRACTION OR DEFECTIVE TELEPHONES."

IT is a great drawback to be too sensitive. The telephone suffers considerably by reason of its sensitive nature. Adopting for its own use a current of a very mild character, its utility is liable to be considerably impaired by interfering currents, such as those used for light or power. This interference may arise from induction or from direct transfer of current. In consequence of this interference the Telephone Company has hitherto opposed all tramway proposals in Parliament or before the Board of Trade, with a view to the insertion of a protective clause, and has succeeded in many instances, but not uniformly, and—as the representatives of the Tramway Association inform us—not always on the merits of the case. Relying on its successes, however, and desiring to avoid the piece-meal method of procedure, the Telephone Company approached the Board of Trade with a view to the adoption of a standard clause for insertion in all future Electric Traction Bills and Orders. To such a proceeding the electric traction interests naturally object, and the question is referred to a Joint Committee of Lords and Commons, which is "to consider and report whether the grant of statutory powers to use electricity ought to be qualified by any prohibition or restriction as to earth return circuits, or by any provisions as to leakage, induction or similar matters, and if so, in what cases and under what conditions. The Joint Committee are to settle the necessary clauses, if they should arrive at the opinion that any prohibitions are necessary.

Messrs. Crompton, Garcke, and Morse have sent us a statement of the case as it is regarded by the Electric Traction Association, and this statement shows that the traction interests will not suffer from any lack of representation. The traction interests intend no longer to stand merely upon the defensive, their view of the question at issue being concisely expressed in the heading of their statement, which we have borrowed as a title to this article.

"The telephone system with earth returns is 'admittedly defective.' It is this system which suffers from traction currents. Remedy this defect, and you will suffer no longer from traction," say in effect the traction interest to the Telephone Company. The neglect to take this course is regarded as prohibitive to electric traction, and it is urged with reason that traction must not be prohibited. On the other hand, there is the Telephone Company with an established system which may be rendered almost useless by the working of an electric tramway. Should a new comer be given the power to render an existing system useless, or put the owners to very considerable expense to make it workable? Here is an issue which is a very suitable one for decision by an impartial tribunal, after full consideration of evidence.

We cannot regard the subject as one which involves only

one set of conditions, and capable of being decided off-hand. There are, in fact, many matters of detail requiring settlement, and at least one novel element to consider. The electrical properties of the earth are likely to give rise to new readings of common rights. These electrical properties have been used for the purpose of transmitting signals of various kinds, telegraphic, telephonic, and railway signals. Have the users for these purposes, by virtue of priority, the right to monopolise the electrical properties of the earth in the same way that a first "squatter" may bring a portion of the surface of the earth within his "sphere of influence," and acquire exclusive rights by "annexation." The electrical utility of earth is common property; no exclusive rights can be allowed for it. It might be regarded as common land. But, on the other hand, is the enjoyment of such common land by peaceful users to be prevented by the proceedings of others, who use it in such a manner as to render it useless to the original occupants? These are one or two of the general considerations which arise on such a question. They will have to be considered in reference to the practical applications.

So far as telegraph lines are concerned, they are protected by the Electric Lighting Act of 1888, which gives the Postmaster-General power to regulate the conditions upon which any electric line or work may be used, so that it shall not injuriously affect any telegraphic line of the Postmaster-General, "or the telegraphic communication through any such line." The same Act protects other person's lines, but not the communications through them. By this Act the Legislature has recognised the principle of protection for telegraphs belonging to the State, but has excluded telegraphs in private hands. Supposing that the State were to acquire the telephone system, there seems to be no doubt that under this Act the Postmaster-General could stop the working of all tramways which interfered with telephonic transmission. As the Post Office use metallic circuits for telephone lines, there is no doubt that any disturbance resulting from the use of earth circuits would only be a temporary trouble under their *régime*, but in case of such temporary protection being necessary, it might be obtained in a summary way. The use of earth as a return for telephone lines may, we think, be regarded as only tentative, and those who desire to use the earth for traction, may reasonably claim that the doubling of telephone lines should be accelerated in order that tramways should not be unreasonably delayed, supposing that the evidence should show that earth working is a necessity for traction.

It is hardly likely that a solution of the question will be found upon the direct issue raised by the Traction Association. There should be some *via media* wherein the minimum of public inconvenience may be found. The developments of practical electricity may show it to be necessary to enforce as a general principle that each user shall keep his current within his own borders. In this way the earth will be only a means for the conveyance of leakage currents, and will not be a medium for directly connecting various sources of supply. The difficulties in the way of metallic circuit tramways may, perhaps, be described as mechanical rather than electrical, they lay in collection rather than insulation. Whatever the reason, the use of an earth return for traction is at present regarded as being due to something more than convenience or cheapness. This is an important practical point, and to it should be given due consideration; but it cannot be maintained that other modes of electric traction have yet been submitted to such practical tests, and have so far failed as to make the earth return the only method available. It is a subject within the scope of inventive ingenuity, and it is not wise to assume that finality has yet been reached. It will always be more easy to use one line than two, but when the use of one line causes disturbance to a neighbour, it may be necessary to show that two lines are impracticable, before permitting the use of one.

The importance of electric traction cannot be over-rated. In all probability it will be a source of considerable employment to electricians, and a means of solving one of the difficulties of large cities that are growing larger. Rapid and cheap transit is a requirement of the times, and electricity will provide it. Its establishment should not be retarded by a too scrupulous regard for supposed rights, and should not be accelerated by failing to recognise one's duty to one's neighbour.

ELECTRICITY IN THE TREATMENT OF CANCER.

The evil of cancer is too great to need enlarging upon here. The very mention of the word sends a thrill of horror through most of us, and the terrible actuality has, either through personal experience or that of some near friend, been brought home to not a few. Of course, for so dire a disease, many reputed cures are promulgated, but little comes of them when put to actual test. It is needless to say that electricity has had its turn. It has been declared a remedy by the rash, a miraculous cure by the charlatan, a useful palliative by some medical men, and a bewildering disappointment by others. What then is the truth of the matter? What is the function of electricity in the treatment of cancer, and how has it exercised that function? Cancer exists, we are told, in the form of destructive cells, which spread and spread till they eat up some vital structure and so cause death. Now the whole body is made up of numerous cells which have to perform certain functions, and each takes its share in that multiform process of change and interchange, called metabolism, without which life cannot continue. The work carried on by these cells is essentially "work" in the engineer's sense. Energy must be put into the body, as into any other machine, in order that the work may be performed. Electrical energy can be put into the body and be made to perform useful work. Hence the possibility of electrical energy doing work upon any cell or group of cells within the body.

We know that electricity can kill the body as a whole, as evidenced by some electric light accidents and by electrocution, and may we, not unreasonably, conclude that it can also kill a part? Can it be made to kill a single cell or group of cells? This would not be difficult if the particular cell or group of cells could be separated and dealt with apart from its surroundings. But it is here that the whole crux of the question comes in. To destroy any group of cells without destroying the whole body is the problem, to solve which will be to cure cancer. The knife has been largely made use of in the hope of cutting out bodily the

destructive, ever spreading growth, and in cases where all the diseased cells are so cut away, the remedy is often complete. Unfortunately the entire removal of all the cells is seldom achieved, no doubt mainly because the full limit of the diseased area is extremely difficult to determine, and, for obvious reasons, surgeons hesitate to cut away and maim the body more than is deemed absolutely necessary.

The power of the electric current, as a "destroyer of diseased tissues," has long been admitted; but the best and most effective manner of using it has yet to be discovered. Some have relied upon electrolytic action, and some upon violent shocks passed through the affected part. None appear to have so far met with more than partial success. Now and then one or other method shows itself effective in individual cases, whilst others obstinately refuse to yield to either. On looking over the medical papers and communications to medical societies on the subject, we find much that is confusing, and little that is conclusive. One after another theories are started, only to be condemned, and practical efforts made which fall short of the hopeful anticipations thrown out.

Leaving for the moment the actual cure of cancer, we find that electricity is credited with considerable value in alleviating the pain. So long ago as 1867, Dr. Althaus said: "One point appears already settled in this matter, and that is, that there is no better means for relieving the pain of cancer than electrolysis." Dr. Vivian Poore, Dr. Hugh Campbell, and many others, confirm this view, while Dr. de Watteville, in his book on "Medical Electricity," writes: "Electrolysis appears to have a sedative effect on the pains of cancer, and deserves a more extensive trial in this respect than it hitherto has had." In December, 1889, Dr. W. E. Steavenson, in writing to the *Lancet*, said: "Electrolysis is no doubt sometimes very useful in cancer . . . . not only to destroy portions of the growth, and thus check the advance of the disease, but noticeably to diminish pain." The writings of German, French and American medical men also bear testimony of the same order, as does the recent work of Dr. Inglis Parsons.

We note with regret that most of the cases in which the electric current has been tried were of old standing, and the disease far advanced. Surely the chance of concentrating the current upon the whole growth is greatest in the earlier stages. In this connection the remarks of Dr. Edgelow are well worth attention. In his book on the subject he says: "It is only in changing the action of the part and destroying the cells that any satisfactory issue can be anticipated. More and more it is becoming clear that at first cancer is local, and if it be then and there dispersed by this beautiful and life-giving process, there is far more hope of what practically amounts to a cure than by any other mode of treatment."

Another point upon which considerable stress is laid by some observers is, that the after effects of an electrical operation, as compared with one by the knife, are very much in favour of the former, both as regards the immediate action upon the system and the contingency of a recurrence of the growth. The knife weakens and enervates, leaving the patient specially liable to a return of the trouble, while electricity strengthens and gives tone to the system, and thus, to some extent, arms the patient to resist a relapse.

So far, then, it seems there is no doubt about the efficacy of the electric current to alleviate the pain, to sometimes diminish the growth and minimise chances of relapse, but that the complete cure of undoubted cases of cancer by its aid is by no means established.

That electricity is doomed to make no further advance in a matter so important to the welfare of mankind we do not believe. Granted that electricity will kill the body as a whole, that it will kill superficial growths upon, or near the surface of the body (such as naevi, &c.), it seems incredible that it should not also be able to kill a part without seriously injuring the remainder, especially when the opinion of some of the most eminent authorities is considered, viz., "that cancer cells are more easily destroyed by the electric current than healthy cells." The difficulty, possibly, is not unconnected with the question of how the current kills in electrocution. When the doctors and other experts can find out how the killing is performed, or, in other words, what function of the electric current is most productive of fatal effect, then, perhaps, that special function may be utilised with a far less expenditure of total energy, so that such operations as the local destruction of cancerous growths may be performed without detriment to the body as a whole.

American Novelties.

THE *Scientific American* has lately been treating its readers to particulars of some electro-medical eccentricities. They take the form of an improved electric belt and an electrical rocking chair. The novelty of the former seems to exist in the fact that it is electric in more than its name. It carries a battery, from the position of which we are led to presume that dress improvers are still in favour with the fair sex in the land of the stars and stripes. How a man is to stow away upon his person this bulky arrangement with its battery is a mystery, and even the stoutest fair champion of woman's rights would, we think, hesitate to burden her cherished figure with a battery of several cells charged with acid and enclosed in a waterproof bag. For once America shows itself behind the times. Electric belts are out of date. We would suggest that the inventor of this eccentricity might do better with it if he re-christened it the "electric bustle." The electrical rocking chair interests us vastly. There is a sort of fascination about it. How delightful it would be could we transform our hard-seated, rigid-backed editorial chair into one of these refreshing indulgencies! After undue burning of the midnight oil, how sweet it would be to sooth our weary brain and aching body by the passage of a mild current of electricity as we sway to and fro with gentle motion! If only the chair would at the same time give out, by some phonographic arrangement, the favourite air of "Rocked in the cradle of the deep," its use would bring ecstacy. But, alas for our blissful anticipations, on looking at the description again we find that a common or garden dynamo is fixed under the seat of this ethereal rocker, and if we would enjoy the refreshing current we must ourselves generate it by driving the dynamo as we rock. Fancy a tired exhausted body being called upon to work a dynamo in order that he may refresh himself by the result of his further labour. Verily the ingenuity of some inventors is great, both across the herring pond and nearer home.

Measurement of Electric Force.

A NEW method of finding the value of the force exerted by a current of electricity in a circular conductor on a unit magnetic pole at its centre has been devised by S. T. Moreland, who describes it in the current issue of the *American Journal of Science*, pages 392-393. The paper is entirely of a mathematical character, but the line which Moreland has taken will be seen from the following. It is known that, so far as magnetic effects are

concerned, a current of electricity in a circular conductor produces the same result as a magnetic shell having its boundary in the circle and satisfying the condition $i = \imath t$, where $\imath$ is the uniform surface density of the magnetism, and t is the thickness of the shell. Moreland substitutes a hemisperical magnetic shell for the current in this case, having "plus" magnetism on the inner surface, and "minus" magnetism on the outer, the total quantity of each of the two surfaces being equal. Then from a consideration of the resultant repulsion of the magnetism of the inner surface on the unit pole at the centre, and the attraction of the outer surface he deduces the resultant force of the magnetic shell.

Influence Machines.

The influence machine has been worked out in such variety of design by Holtz, Tœpler, and other workers, that it is almost impossible for the inventor nowadays to do more than modify the details of old machines. Much, however, may be done in this way to improve their efficiency, to render them less susceptible to the atmospheric moisture and dust, and to simplify the arrangement of the parts. Mr. Wimshurst has just devised an influence machine which shows what can be done in this direction. It may be roughly described as follows:—Take a double Holtz machine and divide each of the fixed plates into two by cutting it through the notched openings for the paper tongues. Turn the fixed plate through a quarter revolution until the field plates are vertical, which will enable the neutralising brushes to be supported on the pillars which support the collecting brushes, and dispense with a separate neutralising rod. The paper tongues which replenish the field plates are to be replaced by metallic brushes. Small metallic brushes are to be substituted for the collecting combs, and the whole is to be enclosed in a glass case to exclude dust and moisture. The design of Mr. Wimshurst's latest machine is very neat, but it does not appear to us that it would give quite so large a quantity per revolution as the old Holtz with its collecting combs.

Candle-Power.

So much confusion is being caused in America by the terms "2,000 candle-power," "1,200 candle-power," &c., in referring to arc lighting, that the Chicago electrical engineers are making a special request to Prof. Elisha Gray to dispose of it at the forthcoming congress, and to replace it by a definite standard of electrical power. In any case, "candle-power" is meaningless enough; but for arc lighting, where everything depends upon the part of the crater exposed to the photometer, it is something more than misleading, it is very nearly absurd. To prevent the litigation and annoyance consequent upon the candle measurements, it is now proposed to introduce a new definition, as follows:—"The term 2,000 C.P. arc to mean an arc produced by 10 ampères and 45 volts potential difference between the carbons; or a 450-watt arc. The candle-power of arcs produced by currents of more or less ampères, or more or fewer volts difference of potential to be rated proportionally." This is a rational system, and will probably commend itself to everybody, except those who pay for the light. In the public mind there is an ingrained disbelief with regard to the accuracy of electrical measurements, a relic, no doubt, of the gas age. The American municipal authorities will require a deal of training before agreeing to take electricity by the watt instead of the candle. When paying for gas light, during the dark ages, gentlemen knew better than to accept a volume and pressure rate; a certain "quality" factor came in, which was quite fatal to such an innocent system. And now that electricians are urging a payment by watt, the wily commercialist will guess that electricity too can be "skimmed" and "sweetened."

The American Electro. Therapeutic Association.

This association has issued a circular giving the particulars of its various committees and the special points which each has to consider. The Committees are on Standard Coils, Standard Meters, Standard Electrostatic or Influence Machines, Constant Current Generators and Controllers, and Standard Electrodes. This looks like business, and we note with satisfaction that the resolution of the Executive Council under which the circular is issued, contains the following paragraph, viz.: "And that physicians, *electrical experts*, and manufacturers be asked to co-operate in making suggestions, and in relating their experience and preference for instruments, with reasons and data." The task involved in the work set these various committees is an enormous one, and we hope they will not be tempted to make reports based upon hastily formed conclusions for the sake of making a temporary impression. Long, patient, and thorough investigation is necessary before order can be evolved out of the chaos that at present prevails in electro-medical circles on most of the subjects they have to deal with. The "points to be considered," as laid down by the council for each committee, are numerous and comprehensive. Much good must come even from their careful consideration, and, when something like reliable conclusions are evolved, medical electricity will have approached measurably near to the condition of an exact science. The American Electro-therapeutic Association has started upon a magnificent undertaking in a most praiseworthy manner and with the characteristic national energy. It has our hearty sympathy and best wishes for its success.

Is the Universe Infinite.

In the *Fortnightly Review* for this month Sir Robert Ball contributes an interesting and suggestive paper on this subject. The conception of space as an infinitely extensive reality is based upon a subtle fallacy. This fallacy is unmasked by Sir Robert Ball, who shows that the popular conception of space is based upon the properties which are attributed to space, while the truth of those properties can only be demonstrated on the assumption that the popular conception of space is correct. Truly an argument in a vicious circle. The whole question turns upon whether Euclid's definition of parallel straight lines is correct, and Ball shows that the definition is neither axiomatic nor capable of proof. Putting it in other words, it is not capable of proof that all the three angles of a plane triangle are equal to two right angles! We have no more means of determining if there is an error in the estimate of the magnitude of the three angles than a man would have of determining the curvature of the earth from a square inch of surface of a pond. Suppose three angles of a triangle are less than two right angles by the billionth of a second—how does this affect the properties of space? We should then have every parallel pair of lines meeting within a finite distance; and it would be possible to travel in a straight line continuously and to return to the starting point in a finite time, having travelled over a finite path. Space, then, need neither be infinite nor need it have boundaries any more than a spherical surface is infinite or has boundaries. Many of the problems of geometry seem to point to such a "curved" property of space—the fact of the return of the Cartesian tangent curve from negative maximum after it has disappeared at the positive maximum, for example. Plane trigonometry resolves itself under such an hypothesis into spherical trigonometry of a limited portion of a spherical surface of unknown radius, and the three dimensions of space would require a fourth in order to satisfy the conditions of absolute infinity. The whole of the ether of space would be a closed globule, perhaps spherical in shape, and matter would be a galaxy of nucleoli inside that globule. As was shown by Stewart, energy may be accounted for by supposing the globule to have a certain rate of change of curvature.

ELECTRIC STREET LIGHTING IN MUNICH.

[FROM OUR OWN CORRESPONDENT.]

IT has been resolved by the Communal Government of the city of Munich to introduce the electric light for the most frequented streets. About 300 arc lamps of various power are to be distributed in the following streets: Maximilian St., with Maximilian Bridge, Diener St., Residence St., Max Joseph St., Residence Platz, Theatine St., Wein St., Maffei St., Promenade Platz, Pfandhaus St., Maximilian Platz, Prielmeyer St., Station Platz, Schützen St., Inner Beyer St., Karlo Platz, Neuhauser St., Kaufunger St., Marien Platz, Cattle Market, Rosenstrasse, Faebergraben, Rosenthal, Sendlinger St., Sendlinger Gate Platz, Provision Market, Gärtner St., Gaertner Platz, Valley, Tsar Gate Platz, Zweibrücken St., Ludwigs St.

In addition, with the aid of a 75-kilowatt battery of accumulators, there is the lighting of the Town Hall with 1,800 glow lamps of 16 candle-power. The motive power is obtained from two water-powers of 300 H.P., one situate in the Westenrieder St., and the other in the Muffat Spring House. The electric machines, each of 250 volts, are introduced by pairs in series on the three-lead system, so that each branch of the system contains groups of five lamps each. This arrangement is adopted so that only one machine is kept in work as soon as half the lamps are disconnected. The mains consist of lead cables laid underground.

The installation will be the first in Germany in which the lighting will not be confined to one or two lines of road, but will extend over a wide area of traffic. An extension of it to double its output is in prospect. The installation is to be in operation by October. The entire station has been entrusted to the firm of Schuckert & Co., of Nürnberg.

THE COST OF PRIVATE ELECTRIC SUPPLY.

By ED. C. DE SEGUNDO.

THE economic aspect of electric lighting and general supply is beginning to receive the attention it deserves. It is only quite recently that the almost universal opinion, that "electric light is, and must always be, much dearer than gas," has been somewhat modified by the convincing testimony of facts. Many writers have done good work in endeavouring to clear away the doubts and prejudices that surround the truth about electricity by direct appeal to figures, and not the least convincing among this band of workers is Mr. Gisbert Kapp, whose long experience of, and practical connection with electric lighting lend great weight to his statements. In a paper recently read at the Society of Arts, Mr. Kapp has drawn attention to several points of paramount importance. He dwells on the fact that electric supply can never become an important monopoly in the same sense as water supply, inasmuch as it is not always practicable, even if it were possible, for the individual to produce his own water supply; whereas, it is always not only possible, but certainly within the power of most individuals who can afford to select the nature of their illuminant, to put down a small plant to generate the necessary electrical energy. Mr. Kapp might have gone further in his argument against the possibility of an electric supply monopoly, only perhaps he considered it unnecessary to remind his hearers that the electric light is not a necessity in the sense that water is, and for the reason that the supply company can only justify its existence by creating a demand for its produce at the current market value. That supply companies fully realise this is evidenced by the substantial reductions in the price charged for current supply that have been made during the last year or 18 months. Prof. Alex. B. W. Kennedy, in his report to the Belfast Commissioners, lays great stress upon the extreme importance, from a commercial point of view, of commencing their supply at a cost which perhaps may involve a loss on the first year's working, in order that customers may be induced to take the light, and by their increasing numbers tend to increase the load factor of the generating station.

Mr. Kapp's remarks on the inevitable result of the manner in which tenders for private lighting are obtained are very true. It must be obvious to any thinking individual that there are several ways of carrying out an order for a plant to supply a certain number of electric lamps, but it is not so obvious to a member of the public that what may be a cheap arrangement as far as initial outlay is concerned, may be a very expensive one in cost of maintenance; nor does it always occur to the would-be customer that the capitalised value of the increased cost of maintenance over that of a better arranged plant may be considerably greater than the difference in the initial outlays. Such questions as these, important though they be, cannot be taken into consideration by the contractor who knows he is in competition with other firms, and that the lowest tender will, in all probability, be accepted. It is his business to secure contracts and therefore to study and conform to public feeling in the matter.

Perhaps the most important suggestion in Mr. Kapp's interesting paper is that relating to the economy effected by overrunning incandescent lamps. Even taking lamps at 3s. 6d. each, Mr. Kapp shows that the interest on the saving effected in the first cost of the installation due to the smaller size of plant necessary (for the same total candle-power), when the lamps are run at three watts per candle, is greater than the increased expenditure for lamp renewals. This suggestion possesses an increased significance in view of the substantial reduction in the price of incandescent lamps, which will be the immediate outcome of the expiry of the patents in November next. It would be interesting to examine in how far these suggestions would apply to consumers supplied from a company's mains at 6d. per unit. In the absence of reliable photometric tests, it is impossible to dogmatise as to the actual candle-power obtained by the consumer. But assuming that he uses a total of seven units per 35-watt lamp per quarter, he would effect a saving of $7 - 7 \times \frac{3{\cdot}0}{4{\cdot}0} = 7 - 5{\cdot}2 = 1{\cdot}8$ units, or 10·8 pence per 8 C.P. lamp by running them at 3 watts instead of 4 watts per candle.

Under the conditions assumed above, this saving of 10·8d. is effected during $\frac{7{,}000}{35} = 200$ hours. If, therefore, the lamps are assumed to last 500 hours, on the average, when being run at 3 watts per candle, a saving of $10{\cdot}8 \times \frac{5}{2} = 27$d. will be made per average 35-watt lamp-life. At the present price of lamps, say 3s. 6d., this would mean an actual economy, because on our hypothesis the *increase* in cost of lamp renewals is $\frac{3s.\ 6d.}{2}$ = 1s. 9d. for 500 hours run, but if we are shortly to have lamps at 1s. 6d. each, the saving effected by over-running the lamps would not only cover the cost of renewals, but would result in a net saving of 9d. per 35-watt lamp life.

The Metropolitan Electric Supply Company have recently instituted a novel system of charging for current supply. For every unit consumed above 8 units per 35-watt lamp installed, the company charge only 5½d. This system has many advantages, one important one to the company being that the lavish installation of unnecessary lamps in a house is thereby discouraged. Such action, though profitable to the contractor, has always worked detrimentally to the general interest of the electric light industry. In the first place the customer is astonished at the number of electric lamps necessary to take the place of his original gas burners, and annoyed at the heavy initial cost of lighting his house electrically. Secondly, the supply company are astonished at his want of common sense and annoyed at the heavy cable they are obliged to run to supply his 400 lamps, of which, perhaps, 50 at the most are in general use, the 400 being all lighted perhaps twice a year. These so-called large consumers are the despair of the engineer of an electric supply company, who is naturally working for a decent lamp and load factor. Under the system introduced by the Metropolitan Electric Supply Company, it is to the interest of the consumer to have as few lamps as possible installed, as he thereby increases the average consumption per lamp. Here, again, the advantage of over-running becomes apparent. Supposing a total of 1,000 candle-power be used under ordinary conditions, running the lamps at 4¼ watts per candle, this would be represented by $\frac{1{,}000 \times 4{\cdot}25}{35}$ = about 120 35-watt

lamps. Taking these to burn on the average 2 hours per day each, about $35 \times 2 \times 90 = 6{\cdot}3$ units would be consumed per quarter. In the winter quarters this would probably rise to 8 units, and in the summer months to 4 units per quarter, so that the sliding scale would never come into operation. But if the lamps be run at 3 watts per candle, about $\frac{1{,}000 \times 3}{41}$ = about 73 lamps would be required for the same total illuminating effect (assuming that if an ordinary 35-watt lamp were run at so high a voltage as to yield 1 candle-power for 3 watts, the actual rate of consumption would rise to 41 watts and the C.P. rise to about 14), and the average consumption per quarter would rise to $41 \times 2 \times 90 = 7{\cdot}4$ units, which would bring the winter consumption to about 10 units per quarter (assuming the consumption from March 25th to September 25th to be half that from September 25th to March 25th). Hence, although the total illuminating effect remains the same in the latter case, in addition to the economy in consumption, advantage can be taken of the company's sliding scale, whereas in the former this would not be the case. By judicious management when the house was being wired, these 73 lamps could probably have been reduced to 50, in which case the saving would have been considerably augmented. For the sake of comparison let us consider the last case numerically.

Conditions.—*House requiring* 1,000 *candle-power current charged for as follows: Up to* 8 *units per quarter per* 35 *watt lamp installed,* 7¼*d., for every unit per quarter above this,* 5½*d.*

Case I.

120 35-watt lamps running at 4½ watts per candle 2 hours per day on the average throughout the year. Consumption assumed to be 4 units per lamp installed per quarter from March to September, and 8 units from September to March. Lamp renewals, one for every 1,000 lamp hours.

Summer.

120 lamps × 4 units × 2 quarters = 960 units at 7¼d. £29 0

Winter.

120 lamps × 8 units × 2 quarters = 1,920 units at 7¼d. £58 0

Lamp renewals $\frac{120 \times 2 \times 365}{1{,}000}$ = 88 at 3s. 6d. £15 8

£102 8

Case II.

73 35-watt lamps overrun so as to yield one candle for every 3 watts. Burning on the average 2 hours per day each throughout the year. Consumption assumed to be 5 units per lamp from March to September, and 10 units from September to March. Lamp renewals, one for every 500 lamp hours.

Summer.

73 lamps × 5 units × 2 quarters = 730 units at 7¼d. £22 0

Winter.

73 lamps × 8 units × 2 quarters = 1,168 units at 7¼d. £35 5

73 lamps × 2 units × 2 quarters = 292 units at 5½d. £6 14

Lamp renewals $\frac{73 \times 2 \times 365}{500}$ = 107 at 3s. 6 ... ... £18 14

£82 14

Under conditions II., therefore, there would be a saving of about 18 per cent. on the original yearly bill for light. Taking lamps at 1s. 6d. each, the saving would be about 22 per cent. Such a possible diminution in the annual cost is certainly worth careful attention.

Mr. Kapp's table showing details of the cost of electric supply is interesting and instructive. It is particularly noticeable that in private houses the electric light is looked upon as a luxury, the cost of which must be, of necessity, high, whereas in business premises the electric light bill receives as careful attention as any other item in the establishment charges. The cost of generating per unit in a private house varies from 10·41 pence to 18·44 pence, and this, irrespective of the number of lamps installed; the highest amount per unit works out—with the irony of fate—in the case of a leading electrician's private installation of only 70 lights, the lowest (10·41 pence) in a private installation at Newcastle. It should be noted, however, that this last figure is based on *estimates* supplied by the owner and not on actual figures.

Deductions from such a table as this cannot be considered as trustworthy, in that the table is representative of so many types of installation, of which isolated examples are quoted, but the general conclusion to be drawn is one which corroborates the results arrived at by the writer in a recent series of articles on this subject, namely, that for small private installations the cost of generation is very high, whereas for installations of 200 16-C.P. and upwards the current can be obtained, from a suitable plant, at a price which compares favourably with that of the supply company, and in some cases, with the price of gas. The lowest cost of generation is recorded at Messrs. Bainbridge & Co.'s works at Newcastle—1·85d. per unit.

In judging of the cost of generation of electrical energy for private use, local conditions should be taken into account as much as possible, otherwise one is apt to form more or less erroneous views as to the real cause of the variations in cost. An inefficient dynamo, a badly attended storage battery, or an uneconomical gas engine will play havoc with any efforts at economy, however great. The most we can do in this table is to reduce the cost of generation in the case of gas engine plant, to a standard, say 3s. per thousand cubic feet, which is very nearly the price of gas in London.

In the following table, column IV. has been calculated in the usual way, and column V. corresponds to Mr. Crompton's definition of the term load factor. Eight examples of gas engine plant have been selected from Mr. Kapp's table.

Gas Engine Plant.

No.	I. No. of lamps. (35 watts.)	II. Units burned per annum.	III. Units per lamp.	IV. Capacity of plant in units per annum.	V. Load factor, $\frac{\text{II.}}{\text{IV.}}$ Per cent.	VI. Cost of generation per unit:—Gas, stores, repairs, wages, and interest and depreciation. (Cost of gas reduced to 3s. per 1,000.)
1	70	1,120	16·0	17,520	6·39	16·27 pence.
2	74	1,448	19·5	26,280	5·50	12·62 „
3	248	10,800	43·5	48,200	22·40	4·96 „
4	300	4,390	14·6	...	6·0	17·83 „
5	480	4,720	9·8	149,000	3·17	12·12 „
6	720	3,600	5·0	153,000	2·35	11·73 „
7	1,090	72,224	66·2	350,000	20·6	3·51 „
8	1,300	50,850	39·1	437,000	11·6	2·50 „

From the above table the effect of the load factor (in the ordinarily accepted sense of the term) on the cost of generation is apparent. Nos. 5 and 6 (Mr. Mitchell of Newcastle and the Duke of Fife) must be left out of consideration, as Mr. Mitchell has only submitted estimates of cost, and the Duke of Fife is, of course, out of town for long periods, during which the light will not be much used. The cost per unit varies roughly inversely as the load factor.

The lamp renewals per unit show some unaccountable discrepancies. Thus Mr. Preece's lamp renewals cost 1·28d. per unit, his lamps taking 16·0 units per annum. Mr. Phillips, whose lamps consume 19·5 units per annum, finds the cost of renewals 0·745d. per unit.

In Sir David Salomons's installation with 14·5 units per lamp, the cost is 0·103d., while at Messrs. Bainbridge's at Newcastle, whose lamps take 66 units per annum, the cost of renewal is 0·182d. Such results present great difficulties in analysis. Opinions differ as to when a lamp should be renewed. Some people burn them to destruction, others renew them when they consider it necessary, others again whenever they have time to think about the matter, and others as soon as the bulb gets at all dark. If Mr. Carl Hering's advice be followed by any large number of consumers the cost of renewals would be very much enhanced. The distribution of the power among the lamps cannot in the long run affect matters, and, theoretically, if observations be taken over a sufficiently long period, the ratio of lamp renewals per cent. to units per lamp per annum should be the same, irrespective of the average annual lamp load.

The ratio is indicated in the following table:—

No. of lamps.	Units per lamp per annum.	Percentage of lamps renewed.	Ratio of percentage of lamp renewals to units consumed per lamp per annum.
70	16·	4·88	0·30
74	19·6	3·47	0·17
248	43·5	3·10	0·07
3 0	14·6	0 35	0·024
1,090	66·3	4·07	0·06
1,300	39·1	1·69	0·042

Note.—In estimating the lamp renewals in the case of Madame Tussaud's Exhibition, I have assumed the cost for incandescent lamp renewals alone to be 0·26 pence per unit.

Column IV. of this table shows that the cost of lamp renewals does not lie in the lamp itself, but in the way the lamp is used. Sir David Salomons, for instance, uses every conceivable precaution for keeping the E.M.F. at the lamp terminals constant. Moreover, he takes a great personal interest in his installation. As a consequence, his lamp renewals are exceedingly low, represented by the comparative figure 0·024 as against 0·30 in the case of Mr. Preece, whose multitudinous duties leave him very little time to spend on his private installation. The figures in this table must, of course, be taken for what they are worth, that is to say, they would only be accurate if the lamps in each installation were burned under approximately similar conditions. But experience shows that the percentage of lamps used on the average varies enormously in different installations. However, the figures in column IV. are reduced to unit amount of energy used per lamp per annum, and may be considered to indicate that with care lamps may be made to last a very fair time. The writer has a 30 v. lamp in his hall, which has run for 2,000 hours at least, and is not appreciably blackened.

The difference between the working of Madame Tussaud's Exhibition (now supervised directly by Mr. Kapp) and Mr. Preece's installation is remarkable. Although the annual lamp consumption at Madame Tussaud's is four times that at Mr. Preece's the percentage of lamp renewals is 0·81 per cent. less. This means that while at Madame Tussaud's the lamps do four times as much lighting as at Mr. Preece's house, the proportionate number of lamps renewed is practically the same. In other words, at Madame Tussaud's the lamps last four times as long as at Mr. Preece's house. No illustration could be more strikingly indicative of the impossibility of dogmatising as to the life of a lamp. Mr. Kapp's paper has given us the means of deducing this very important fact, and electrical engineers should be grateful to him for thus placing beyond a doubt the large "personal factor" in the life of an incandescent lamp.

It has been assumed in the above calculations as to economy in over-running lamps, that a lamp so treated will last half as long as one burned under the ordinary conditions of 4½ watts per candle. But, as far as I am aware, there is no reliable experimental corroboration of this assumption, so that the degree of over-running and the degree of economy resulting therefrom will be conditioned by the degree of efficiency to which lamps manufactured under new processes will attain, and to a large extent by the "personal" element above alluded to.

Mr. Kapp has introduced a fresh interpretation of Mr. Crompton's "load-factor," and pleads as his excuse that in some of the private installations he has been connected with, machinery has been put down in duplicate and was therefore not in the same position as a central station. But in such cases why should the load factor not be calculated on the capacity of one-half of the duplicated plant? The capacity calculated from the maximum observed load is not a sufficiently trustworthy basis. In the first table, the writer has re-calculated the load factor in the examples of gas engine plant in accordance with Crompton's definition. It is obvious that, except in Sir D. Salomons's installation, the ratio of maximum observed load to capacity of generating plant in the examples quoted in Mr. Kapp's table precludes the possibility of anything like 100 per cent. reserve, and if people like to have an unusual amount of reserve it is only fair that this should be taken account of in the load-factor.

Mr. Kapp has been to no small trouble in collecting and tabulating the information contained in this paper. It has been published in a journal which has a wide circulation amongst the class of people to which this paper appeals most strongly, and doubtless it will do good service in demonstrating, among other truths, the truth of Mr. Frank Bailey's remarks during the discussion, as to the importance of consulting an impartial authority before proceeding with such a purely technical matter as an installation of the electric light.

Norwich Telephone Service.—Under the heading "Telephones—cheap and efficient," the *Dereham Standard* announces that the Norwich Telephone Company has been formed with the object of supplying a cheaper and more efficient telephone service.

SOME NOTES ON THE DESIGN OF SERIES MOTORS FOR TRACTION.

By J. DOUGLAS DALLAS.

(*Concluded from page* 573.)

We shall now proceed to discuss the matter of gearing, under which heading many of the difficulties which were first experienced may be included. First, as to pinions, these may be either composition or steel:—

1. *Cast-steel pinions* are too hard and brittle to come into general use; although the surface of the teeth soon becomes polished, the noise in operation is very great.

2. *Forged steel pinions*, perhaps, give the best results; the wearing surface is good, the noise is much reduced, the life is prolonged, and the teeth not liable to break.

3. *Laminated steel pinions* also give good results, but the cost precludes general use.

4. *Cast-iron pinions* have been used, but are unsatisfactory.

Gun metal, or composition pinions made of silicon bronze, manganese bronze, aluminium bronze, &c., all gave excellent results, the teeth being, of course, cut out by milling machines; they are free, generally speaking, from liability to break, and soon get a good wearing surface. The life is long, although the noise is somewhat greater than in the case of forged steel. They have been much used in double reduction motors for armature and intermediate pinions; the price is greater than that of steel. The method of cutting the teeth is the same in all cases, two pinions being made at the same time, in the following manner:—A cylinder is taken somewhat larger than the finished diameter and with twice the length of face: this is first carefully bored and the keyway slotted; the teeth are then cut in a milling machine, and the cylinder turned down to exact dimensions and sawn in half. All axle gears are, of course, split gears; but intermediate gears, when used, are made in one piece. They are universally made of a fine grain of cast-iron with the teeth carefully milled out from the solid disc. Rawhide pinions have been tried; they reduce the noise very perceptibly and, while new, work satisfactorily; however, they soon begin to wear and then rapidly go to pieces. Pinions of alternate layers of rawhide and sheet-iron have been used. As soon as the edges of the leather begin to wear, the sheets of iron act as so many saws and rapidly pit the gears. They are an abomination. Wooden gears of white maple have been tried also with teeth of other woods; they are not satisfactory when run at the speeds met with in tramway work.

A very important condition of working is the protection of cars from lightning discharges. Storms in America are of greater frequency and intensity than met with in Europe generally. As will be seen by reference to fig. V., the

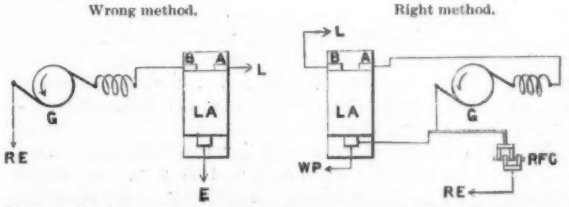


Diagram showing wrong and right method of connecting lightning arresters in generating station.
E, earth; G, generator; L, line; B E, to rail and earth; L A, lightning arresters type B; W P, to water pipe; B F C, rail feeder clamp.

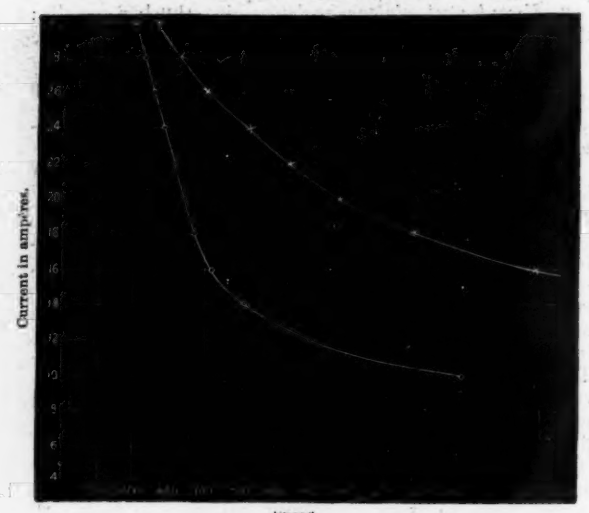
FIG V.

lightning arrester is so placed between the trolley wire and earth as to entirely preserve the motors from the effects of a discharge. The drawing will readily explain itself.

Wiring of Cars.—Two methods have been adopted in wiring two motors on to one truck when the two motors are in parallel.

In the first method both the armatures and field coils are in parallel, and one reversing-switch only is required. Previously it was supposed that this was the only method by which the two motors could be worked in parallel. This idea has proven to be not only fallacious but a positive source of evil. Let us suppose two motors, identical in

every other respect, but of two different grades of metal; calling the two frames A and B, we shall suppose that A is of a higher permeability than that of B, consequently, with the same number of turns of wire on each field, the induction of A will be greater than the induction in B, as the current will divide equally between each field, as it might have been assumed that the resistance of the two fields would be the same. This will not be the case, however, with respect to the two armatures; the current will not be the same in each, for the two field magnets have two different strengths, and as the speed of the two armatures must be the same, the back E.M.F. in each armature will be different. Let M and N, represent the speed curves of the two



Speed curves of motors:—I. Fully saturated field; II. Partially saturated field.

Figs. M and N.

motors, and let us take the case when the car is travelling at such a speed that the armatures revolve at 700 revolutions per minute. Draw at this point an ordinate to intersect both curves; B takes 12^a, A takes 9^a, so that the motor, B, is doing 25 per cent. more work than A. Next take the case when the car is running under a heavy load on the level, and going at about 550 revolutions per minute. Motor B now takes 27^a, while A only takes 17^a, so that B is doing 37 per cent. more work than A. Further, when the car gets upon a curve or gradient, some point will be reached where the induction in the field of A will be so different from that in B, that its armature may actually become a generator, and send a current through the local circuit of the two armatures. This method of wiring was the cause of many armatures having been burned. Another objection to this method of wiring is that should one field coil be accidentally opened or broken, the armature would be short-circuited, practically, with 500 v. across the brushes. Such accidents have occurred. Putting the two motors in parallel, without a connection between each set of brushes is the method now adopted. Two reversing switches are, of course, necessitated by this form of wiring, but the same current must flow through the armature as flows through its field coils, and in this way, even where two widely different qualities of metal may come together, such as high Bessemer steel (poor permeability) and wrought-iron, the load distributes very evenly between the two motors. In practice, of course, care is exercised that the two motors on the same truck are as nearly as possible of the same quality of metal. The method of wiring cars by placing the two motors in series, has also been largely resorted to by the Sprague-Edison interests, the writer understands; but he has had no experience in this method of operating cars; he can venture no opinion as to its merits compared with the parallel system.

We shall next proceed to examine the methods of controlling the starting and stopping of cars.

The Westinghouse Company formerly used a rheostat consisting of sheet iron coiled the shape of a cylinder, and insulated with asbestos paper; each magnet limb had two bobbins of wire, A and B, A_1 and B_1, coupled in parallel to A and B in series. The first adjustment of the controller placed the resistance in series with the two sets of two bobbins in parallel. When the resistance has been cut out of circuit, and it is required to increase the speed, the two large coils, B and B_1, are left in circuit in parallel, A and A_1 having been cut out. The last adjustment of the controller cuts A and A_1, the two small bobbins in multiple, at the same time that B and B_1 are cut out of circuit. The above method is now superseded by a better one, the writer understands.

2. *The Thomson-Houston Car Controller* formerly consisted, essentially, of a rheostat with one or two reversing switches, the motors being connected in parallel. A modification of this plan has now been introduced with a view to control the direction of running, as well as the speed of the car, with one and the same handle. In the older method there were two handles, one to alter the adjustment of the connection on the rheostat, the other operated the reversing switches. This method had, amongst other drawbacks, an expensive rheostat, and the liability of reversing the connections before the field circuit was broken. In the new method of control, all connections are made from the platform of the car. With the controller in a central position all connections are broken; on turning the handle one way, the first connec-

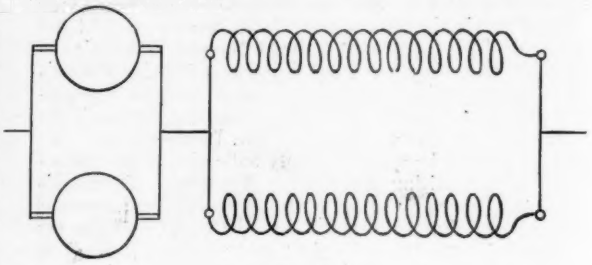


Fig. P.

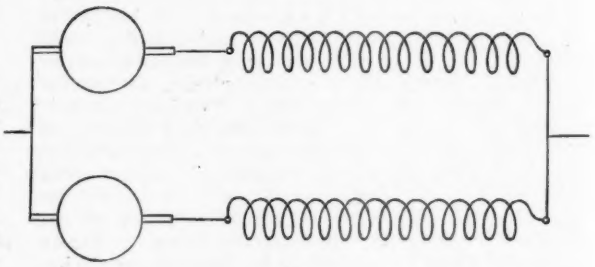


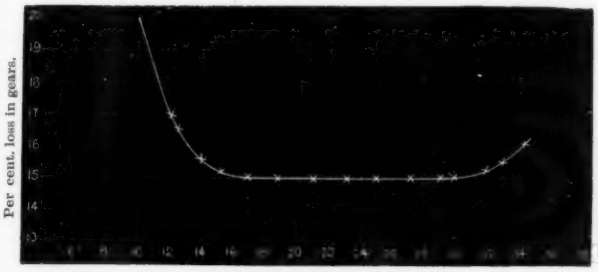
Fig. Q.

tion places both motors in series with the rheostat, second connection cuts out the resistance; third, both motors are placed in parallel; fourth, both motors are placed in multiple on the loop. Turning the handle the other way from the central makes the same connections, except that the motors are reversed. This method allows of the maximum torque being employed with the minimum waste in the rheostat.

Sprague-Edison Method.—"In starting the car the switch handle is turned from the position marked off with a counter-clock-wise movement, which has the effect of carrying the arm of the rheostat, placed under the switch, around on its contact segments, and the resistance is gradually cut out of circuit. After this arm has been carried around, and all the resistance cut out, it is released from the cylinder shaft and left locked in this position. Further movement of the handle then affects only the cylinder, and commutates the field magnet coils of the motors from series to parallel in the usual way. In stopping, the field coils are turned from parallel to series, and the resistance then cut in. The rheostat is of the regular circular type, made of stamped sheet iron, with a shoe of brass instead of iron, on account of the better wearing qualities of the former; the circuit is now broken on the rheostat instead of on the cylinder." (*Electrical Engineer*, New York, *extract.*) The contact shoe is a copy of the Thomson-Houston one in every respect, and the only difference between the rheostats is, that the Edison Company have omitted the electro-magnetic blower. On breaking circuit a bad spark must be produced, which presumably would shorten the life of these contacts very considerably. The Sprague-Edison motor (now, the author

understands, superseded by a more recent type) consisted of a horse-shoe magnetic drum-wound armature with double reduction gearing. The field windings on the motor consisted of six separate bobbins, three on each limb. The method of operation and controlling of speed was effected as described in the above extract.

The Loss in Different Forms of Gearing.—As practically the only forms of gearing which have been used have been either single reduction or double reduction spur gearing, it will only be necessary to give the per cent. losses in these two classes. The curve, fig. R, is prepared from curves of



Electrical horse-power input.

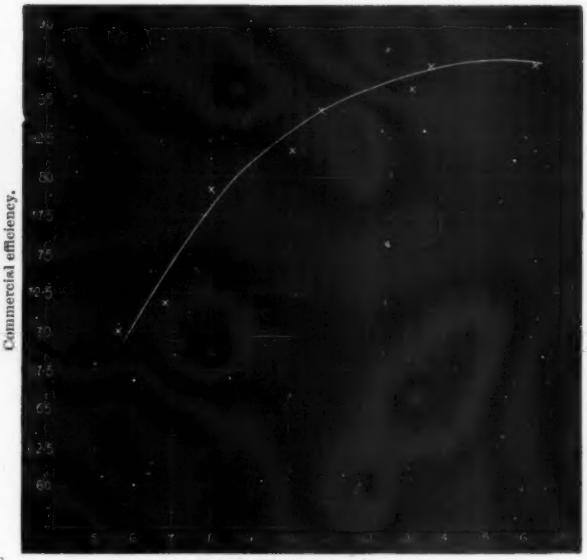
Short railway motor curve of double reduction gear loss. Data educed from curves of efficiency and brake horse-power. $E.H.P. = \frac{B.H.P.}{Com.\ Eff.}$

FIG. R.

efficiency with and without gears, taken by Mr. Sidney H. Short, on a railway motor of his own design. (The curves and data were published last year in the *Electrical Engineer* of New York.) The electrical H.P. input has been prepared from the curves of mechanical efficiency by dividing the mechanical horse-power output by the efficiency at that point. The difference between the efficiency curves with the gears and without gives the per cent. loss in the gears, as will be seen from a point where 12 H.P. to one where 31 H.P. was absorbed; in fact, for all working loads the loss is 15 per cent., which, of course, is very large. At some small load all the power developed would be absorbed in the gears, and in the same way, at some very great load, all the power would be taken up in the gears. With a single reduction gear approximately 6 per cent. was lost in the gear for all working loads. The gear under test in the second case consisted of a wrought steel pinion with 14 teeth, the axle gear of a cast-iron machine-cut spur-toothed wheel of 67 teeth. The loss was obtained very carefully after a series of tests, and only accepted after very careful verification. In single reduction gear, carefully made, the reduction should never exceed this. Again, referring to the Short motor mentioned above, as will be seen, the efficiency is wofully bad, the average, on Mr. Short's own showing, being only 52·5 per cent. between 7 and 15 B.H.P. output, so that the core losses, $C^2 R$, &c., must have footed up to 32 per cent. The single reduction motor efficiency is a great improvement on this, showing what a great advance has been made in two years' time in the design of tramway motors in the United States. The single reduction gear losses were those of the Thomson-Houston type. The average efficiency of a new 50 type of motor is nearly 78 per cent. for all working loads, so that after allowing 6 per cent. for the loss in the gear, the core losses, $C^2 R$, &c., have been reduced to 16 per cent., or half what they were before. It is a question whether such an efficiency will be much improved upon, for so doing would necessitate either :—

1. The increase of weight.
2. The increase in the number of poles.
3. The increase of speed.

If such a motor is designed, it will be probably of a multipolar type. A regular W.P. 30.-motor weighs, complete with gear, 1,900 lbs., which motor in its essential details will be the standard single reduction gear motor for some years to come. Although gearless motors will be used in the future, it is questionable whether they would be at all suitable for operation generally on roads. With a 30-inch wheel, at six miles per hour, the axle would be revolving at only 35 revolutions per minute. To design a motor which would be of reasonable dimensions and weight, and which could start on a 6 per cent. gradient, is a knotty problem. For level roads with high speeds and few stoppages, gearless or axle motors will have a great future. Mr. Parshall has recently read a paper before the American Institute of Electrical Engineers, in which he describes a motor of the Edison type, having an efficiency of 87 per cent.; however, as this curve continues to rise (*vide* fig. T), its accuracy may be doubted, and the writer inserts it for what it is worth.



Electrical horse-power input.

Curve of commercial efficiency and electrical horse-power of No. 6 Sprague Edison R. R. motor, taken from data supplied by Parshall

FIG. T.

In conclusion, there is only one other topic which we shall touch upon—brushes and brush holders. Much trouble, at first, was experienced with the commutators, principally caused by the brushes making bad contact, wearing unevenly, &c. The brushes are invariably made of carbon. The best brush incomparably is that of Carré, in respect of wear, condition of commutator, and life of brush. An ideal brush should, if possible, be free from grit, should not smut the commutator, and, while not being hard and brittle, it should, on the other hand, not be too soft, but of a medium fine texture. A very hard brush will wear well, but is liable to collapse. A brush of too soft a material will smut a commutator; they are liable to pit badly and cause flashing.

ELECTRIC COOKING AND THE LOAD FACTOR.

THE demand which is slowly, but surely, being coaxed into existence for electric sundries in the household is likely to have a most healthy action in increasing the load factor of our central stations, and in coming to the rescue of those engineers who have at present reason to groan over the day-load, or, rather, want of it. A full discussion of culinary ethics and kitchen economics is more suited to the columns of one of our contemporaries, or else to the quasi-scientific pages of some of the ladies' journals, where the attempt is made to provide mental pabulum covering a range which includes Mary Ann in the kitchen, and Mary Ann's mistress in her boudoir. It is in its effects, rather than in itself, that electric cooking is of interest to us; but it may be well to chronicle the advances which have been made in some directions in the art. Of course, for some time to come electricity will be a luxury, or, at the best, an expensive necessity to those who dabble in the enticing and scientifically-cleanly appliances which are now so much in evidence at the hands of Mr. Dowsing, and associated with the names of Carpenter, Binswanger, Crompton, Hirst, and others.

The first asbestos-covered wire resistance coil appliances were sadly deficient in even the most elementary design and the

wonder is that they did so well; but some of the recent patterns have a claim upon our attention, if only as examples of evolution, a proof positive that efficiency is only to be obtained by a mastery of details, and by keeping in view the laws upon which even the simplest action of our domestic life is based. Where heat has to travel, air spaces have been done away with where not wanted, although they are very useful at present until the vacuum jacket which has been promised becomes *un fait accompli*, and is available as a non-conducting wall for heat vessels.

Carpenter in the States, and Crompton in England, have buried highly-resisting wires in enamel, and such an arrangement has been exploited with fair success. About the same time, Binswanger and Hirst began to use a special vitreous cement, with platino-iridium wire embedded in it, and they, too, have found that despite the present costliness of such utensils, there are members of the moneyed public to whom convenience and novelty outweigh the, to them, small additional expense. Of course, the dealers benefit in the first instance, and the central stations always, so the latter cannot but regard such enterprising firms as their best friends in a time of need. The last-named vitreous enamel can be applied to any existing vessel, and the absence of firing marks the distinction between it and the Carpenter system. Recent tests have shown that the heating of water is practically (a self-evident fact to the most primitive physicist, the most trying task electricity can be given.

The first design of heater was akin to the toddy ladle, but was soon displaced by a kettle provided below with the resistance wire. In such a form a kettle containing two pints of cold water can, it is said, be brought up to boiling point with 5 ampères at 100 volts, in from 16 to 18 minutes. If we say 20 minutes, to be on the safe side, it may be taken that one-sixth of a unit would be required for each charge; that is, at present average prices, it costs ½d. to boil 1 pint of cold water by electricity. Sixty watt-hours have achieved this feat under test conditions, and the application of the principles of calorimetry have caused the efficiency to go up till little further can be expected as to improvement in this direction.

Seventy-five per cent. to 80 per cent. can be guaranteed as a return of the total heat energy of the current supplied, and no perceptible difference has yet been found between the effectiveness of alternating and continuous supply. The loss is simply one of radiation which it is impossible to altogether overcome. Where this has been counteracted, 90 per cent. return has resulted. Bolder attempts are being made with large ovens and appliances for hotel kitchens, and with these notable results have been obtained. Mr. Binswanger's latest oven, 20 inches by 14 inches by 18 inches can be kept up at 350° F. to 400° F. for three hours by an expenditure of 1,200 watts if it has been brought up to working heat with 1,800 watts, and the first heating of the contents done with this energy.

In the latest small heater, 1 pint of water can be raised from 15° C. to 100° C. by 75 watt-hours, showing an efficiency of 73 per cent. The small curling-iron heater takes ¾ ampère at 100 volts for 1½ minutes to raise it from 15° C. to 200° C., say, a demand of 75 watts for an infinitesimal time per diem. Irons of large sizes are being handled. A tailor's goose, weighing 15 lbs., while at work, takes 4 ampères at 100 volts, or 400 watts, say, 2d. per hour. The surface heater for badly-ventilated rooms and offices of about 10 feet by 12 feet, to maintain a temperature of 60° F. during winter weather, absorb 5 ampères at 100 volts, or half a unit per hour, and although outrageously extravagant compared with gas fires, there seems to be a likelihood of many a City man blessing the company which burns coal across the river to supply the heat for his comfort in the densest part of the City itself.

It cannot be enforced too strongly that the cost of all such service performed by electrical means must always be far above anything chargeable to gas. To produce heat by the operation of the C^2 R law means the erection and maintenance of three separate sets of plant at one locality, the losses in which must certainly be paid for by the consumer, and in addition to this he has to pay his share of the maintenance of a costly and extensive system of mains and converters—a system whose capitalised cost reduced to per unit per consumer is out of all proportion to the equivalent in a net-work of gas mains.

To supply 200 heaters of the size mentioned would require a boiler, an engine, and a dynamo plant, each of 100 kilowatt capacity, whereas for gas supply the storage provided would be capable of dealing with many thousand such appliances and call for no increase.

Notwithstanding this fact, there is no doubt that the sooner central stations follow the lead of the gas companies and inaugurate, by their own efforts, a system of hiring, of hire-purchase and rental of domestic heating and cooking appliances, the sooner will their profits be proportionate to the scientific successes of the industry.

If the domestic applications do not do all that some fondly hope they will do for electricity, they will at least assist the other economies which are already being practised by station managers, and tend towards that desirable result—the payment of a fair dividend to the shareholders, and a proportionate remuneration to those engaged in the operations of supply. Approximately, the cost of heating by electricity is about ten times the cost of gas, taking gas at 2s. 6d., electricity at 3d., and theoretical efficiency.

MODERN GAS AND OIL ENGINES.*

Mr. Spies continues his paper on the above subject, referring, first, to the ease of adaptation of some engines to gasoline; the Otto, for example, having an additional small pump to force the gasoline to a small brass pan, whence the proper amount is drawn by the passing air which sprays the liquid, the Caldwell-Charter engine having a similar arrangement.

In the Roots engine the Otto cycle is worked, but in a special manner, the explosive mixture being slightly compressed in both the cylinder and a compression chamber, which opens laterally from the cylinder, by an opening past which the piston moves in its travel. The piston, therefore, compresses in the extreme end of the cylinder a portion only of the mixture, and this is fired as usual. As the piston travels out it lays open the lateral port to the compression chamber, and the gas in this is then compressed by the pressure of the exploded charge in the cylinder, and also fired, and there is a second heavier explosion acting upon the moving piston. There is thus a deep valley in the expansion curve of the diagram, and the main charge is exploded at a compression of about 120 lbs., which is claimed to effect economy.

In the Palatine engine the crank works in a closed chamber, which serves as a compression chamber in which the upward moving piston compresses a cleaning-out charge of air. Gas is admitted by a pump and the Otto cycle is used.

In the engine of Mr. Campbell, who somewhat objected to our general criticism of gas engines, the Otto cycle is not used, but there is an explosion every revolution, air and gas being taken in by a pump driven by a pin in the fly-wheel, admission being controlled by a slide. The compression of the explosive charge is timed to act as a scour, forcing out the used residuals, but being itself stopped from escape by the returning piston coming over and closing the exhaust port, which is placed well forward in the side of the cylinder. The power of the engine is regulated by the ordinary hit and miss device, modified to never miss, but to give a varying opening of the gas valve.

When Mr. Campbell speaks of the sheep-like following of the Otto cycle, he should remember that with all its faults the Otto engine, as made at Openshaw, has one valuable feature. Its worst enemies cannot refuse to allow that the design, workmanship and finish of the engine as a piece of machinery is far ahead of the same qualities in many other gas engines. The present writer has two engines working alongside, one an Otto, the other of another type. There can hardly be two opinions as to the appearance of the two, and yet the writer was himself somewhat responsible for the ordering of the *other type*, which does certainly work in a very excellent manner, exploding every out stroke when necessary.

The electric igniter of the Foos engine—an American—is explained, the spark being produced by the contact, and immediate separation of two electrodes, the contact and separation being effected by the revolution of one electrode, which is made semi-circular. In the Priestman engine the highest proof petroleum, or best lamp oil, is best, a sprayed jet of

* See Electrical Review for April 21st, 1893.

oil being further broken up by a jet of air, then heated by the waste products of the engine, and exploded under compression by electricity.

This second paper closes a purely descriptive account with the Kane engine, suitable for either gas or liquid. This engine is built in Chicago for launch purposes. When used with gasoline, a carburator is employed, in which air is drawn through the liquid, and absorbs sufficient to become explosive by passing over a large area of the liquid. Of this arrangement we might add that, when liquid is thus absorbed by air, it is of importance that it should be of equal evaporative quality throughout. We have found, when experimenting with carburators of this form, that after running well for some time the carburators appear to fail in action, though full of liquid, as though the more volatile portions had been first absorbed, and the remainder was too slowly taken up to make an easily exploded mixture, the result being slow, imperfect explosion and reduced power; this, too, with an engine which, when started on a newly filled carburator, gave a horse-power something like 20 per cent. greater than it would give with Manchester gas, the indicator diagram being altogether fuller than the gas diagram, and showing the gasoline to be much more powerful. But this did not continue beyond the exhaustion of the more volatile constituents of the hydro-carbon liquid.

ELECTRICITY IN AGRICULTURE.

VERY little satisfaction will be afforded the members of the Senate of the United States at the results of their indirect investigations as to the utilisation of electricity in agricultural and horticultural operations, whilst to those more intimately interested the outcome will not cause any surprise. It is only a year last April that, in compliance with a resolution of the Senate, the consuls and other agents were instructed by the Department of State to prepare reports on the use of electricity as a power in the operation of farm machinery and implements, and in the propagation of plants in their respective districts. As a matter of course, a large number of replies was received, and, as might have been anticipated, they were unsatisfactory as a whole. Many of them merely mentioned the fact that the use of electricity in connection with agriculture was unknown in the localities concerned, the remainder stating that its applications were mainly confined to lighting, or giving what may now perhaps be regarded as historical information.

In the case of France, the reports received from the districts of Marseilles, Nantes, St. Etienne, and Roubaix, show that nothing has been done in the directions mentioned, whilst that from Rouen refers to experiments made at the Paris Exhibition in 1878, and to the attempts made to destroy microbes invisible to the naked eye by passing current in buckets where seeds were washed preparatory to sowing. Belgium appears to have only one application, this being the transmission at Chassart of about 12 H.P. a distance of half a mile for the operation of a thrashing machine.

A somewhat lengthy report of an historical nature is due to Mr. A. H. Washburn, of Magdeburg, who states that as far as German experiments go, the substance of most of them shows results decidedly adverse to electricity, at least to its employment as a practical factor. Dealing with the influence of the electric current upon vegetation, he first refers to the tests made by one Helmert, as early as 1859 with pine tree seeds, peas and lettuce; to the experiments made two years later by Fichtner with barley, peas, wheat and buckwheat; by Tschinkel on the influence of electricity on plant growth in 1882; by Prof. Wollny at the Munich Exhibition in the same year and in 1883; and by Prof. Holdefleisz on an extensive scale in 1884. As far as the influence of the electric light on vegetation is concerned, the experiments of Mr. C. W. Siemens in 1880 are specially mentioned. Electricity for motive power purposes in agriculture has not been adopted. This view is confirmed by the reports from Cologne, Crefeld, Dresden, Frankfort and Mannheim and which are devoid of any information regarding electricity as an aid to vegetation. The position in Austria is summed up by the statement that although farm machinery operated by electricity was shown at an exhibition held in Prague four years ago, the agriculturists of Bohemia did not take up the idea and put it into practical use. Labour is so cheap and the landed proprietors feel the obligation of keeping the peasants dependent upon them supplied with work, that a surprisingly large amount of field labour is done by hand, even where there is machinery by which it can be done. The replies from Spain (Barcelona and Cadiz), Italy, Holland, the Bahamas, Nova Scotia, St. Christopher, St. Hyacinth, British Guiana, Colombia, Cuba, Dutch Guiana, Peru, Venezuela, Ceylon, China, Morocco, Australia and Fiji are practically all in the same strain, showing that electricity is not used for driving agricultural machinery or in assisting the growth of plants.

As far as concerns Great Britain, Mr. Burton of Birmingham states that with the exception of experiments made by Mr. Chamberlain, nothing has been done in that district in the application of electricity in the growth of plants. He, however, gives a copy of the paper read in 1880 before the then Society of Telegraph Engineers by the late Sir William Siemens, on "The Effect of Dynamo-Electric Energy upon Horticulture as a Promoter of the Chemical Changes by which the Plant takes its Chief Ingredients of Food from the Atmosphere." Nothing of interest is forthcoming in the reports from Glasgow and Leeds, but Consul-General New, of London, gives an account of the electric dairy started last year at Stansted by Mr. J. Blyth.

The above is the substance of the replies received by the United States Government, and which, as already mentioned, will give little satisfaction to anyone.

RAILWAY ACCIDENTS.

THE Board of Trade returns recently issued show that during the year ending December 31st, 1892, there were 28 collisions between passenger trains, and 43 collisions between passenger and goods trains, resulting in the death of 20 passengers and three servants, and injury to 419 passengers and 43 servants. In addition to this, other rolling stock accidents resulted in death and injury to others, bringing the total killed to 30, and injured to 693, as against 17 killed and 1,029 injured for the previous year. Accidents from other causes, including trespassers, contractors, workmen, &c., bring up the full total to 1,130 killed, and 4,485 injured, as against 1,168 killed, and 5,060 injured for 1891; being a total decrease of 38 killed and 575 injured.

The following extracts and remarks from the reports thereon are of interest from an electrical point of view.

The accident which occurred at Bishopsgate station on the Great Eastern Railway on June 14th, the details of which will no doubt be within the memory of most of our readers, elicits the following remarks from Major-General Hutchinson:—"There is no doubt that the suburban line station at Bishopsgate is dark, though lighted with double gas burners at frequent intervals; with better light it is quite possible that the driver of the Enfield train might have seen the tail of the Walthamstow train in time to have stopped before reaching it. I am glad, therefore, to learn that the station will shortly be supplied with the electric light. . . . A rail contact should be fixed near the Bishopsgate north up home signal, to ring a bell in the signal cabin when a train is passing it."

In reporting upon the accident which occurred in a cutting between Devonport and Saltash on September 12th, when an engine and six ballast waggons left the rails, resulting in the death of the guard, Major Yorke observes:—"This collision compels me to draw attention to the unsatisfactory nature of the rules in force for block working at this (Hatton) junction. According to these rules the signalman at Hatton is authorised to give 'line clear' to Budbrook station for a following train as soon as the preceding train has passed the clearing point, or in the exact words of the instructions, 'When the line is clear to the clearing point.' The clearing point on the down main line is the home signal, so that a train may be standing with its tail just within and close up to this signal, and at the same time 'line clear' may be given to Budbrook to permit a second train to approach the same

signal, the two trains, under such circumstances, being separated only by the thickness of the signal post. In the case under investigation, the train was standing 63 yards inside the home signal. The inspecting officers have already pointed out the risk attending such a mode of working, and have expressed their opinion that it cannot be regarded as a safe system of block working, which, according to Board of Trade requirements (No. 1), should ensure 'an adequate interval of space between following trains,' a condition which is certainly not fulfilled by a space of a few inches. At Hatton junction the risk is increased owing to the fact that the home signal referred to is 89 yards from the cabin, and the signalman cannot see with absolute certainty whether a train is entirely within the signal or not, so that it is possible that the tail of a train might be outside the home signal at the time 'line clear' was given for a succeeding train."

In dealing with a collision which occurred at Sandhills Station, on the Lancashire and Yorkshire Railway, on August 15th, the same inspecting officer strongly animadverts upon the impropriety of allowing block signalling apparatus to be used for private signalling between officials. Upon this there can be no two opinions. The block signalling apparatus is provided for signalling the trains, for their protection, and consequently for the protection of the lives of passengers travelling in these trains, and any improper use of such apparatus cannot be condemned too strongly. We quote Major Yorke's remarks hereon with pleasure :— "Another irregularity came to light in consequence of this collision, and that is as to the irregular and unauthorised mode adopted by the signalmen in Nos. 1 and 2 cabins, for communicating with each other. There is a definite rule that the block instruments are to be used only for block working in strict accordance with the rules. In spite of this the two signalmen seem by their own admissions to have been in the habit of communicating with each other by means of the loopline bell, which is intended only for shunting operations. The custom is in this case inexcusable, as there is a telephone in existence between the two cabins. Altogether it seems that some laxity of working has been allowed to gain a footing at Sandhills, and it is to the non-observance of the strict rules for block working that this collision must be attributed."

Referring to the collision which occurred on December 8th, 1892, on the same line, at Phillip's Park Junction, on the Ardwick branch, Major-General Hutchinson remarks :— "This collision would probably have been prevented if the electric locking of signals, combined with treadles or some other arrangement, had been in force."

On May 27th, at Derby Junction, Birmingham, on the London and North Western, there occurred, as will be remembered, a most serious—and in the sense that the two trains which collided ran for some distance actually side by side without noticing one another—a most extraordinary accident. The two trains had to pass over the same line on reaching the junction ; the driver of the Midland train mistook the junction signals which were against him, and at the junction the two trains came together, resulting in the death of two people, and slight injuries to several others. The accident was entirely due to the mistake of the driver, but in commenting upon it Major Marindin condemns the practice of allowing trains to be sent forward to a colliding point merely under caution. There can, in our opinion, be no question of the desirability of abandoning any such practice, and working all junction sections strictly under block rules. Where trains have to connect, as in the case in question, it no doubt is desirable there should be as little delay as possible ; but having regard to the fact that beyond the junction the trains have to be kept apart the distance of the block sections, whatever that may be, it is clear little, if any advantage, can attend their approaching the junction at a shorter distance in either time or space. The junction sections should, with the object of facilitating traffic, be as short as is possible with regard to safety, and no two colliding trains should be allowed to enter the junction section at one and the same time.

These remarks refer in like manner to the accident on the Midland at Esholt Junction on June 9th, where two trains travelling in opposite directions came into collision, due to the non-observance of signals by the driver, he having been sent forward under caution.

The unfortunate collision which occurred near Clapham Junction, on August 20th, between a passenger train and a train of empties, on which occasion three vehicles were burnt owing to the rupture of the gas cylinders or connections, and which occasioned the death of the guard, will be within the memory of all. The collision, although of a most serious character, typifying that which might on any occasion result from railway vehicles carrying gas when in collision, did not attract that attention which might have been, from its serious nature, expected. The collision itself was the result, as will be remembered, of apparent neglect on the part of the driver of the passenger train in over-running the signals. With regard to the collision itself, Major Marindin remarks :—

"The empty train was driven forward for about 28 yards, and the two rear vehicles were telescoped, one of them being thrown on to the top of the engine, where, owing to the fracture of the compressed-gas cylinders and the instantaneous ignition of the gas, it was very soon in flames, and, together with the two vehicles next to it, was entirely consumed.

"The guard, George Weblin, who was riding in the brake-compartment of the rear vehicle, was thrown on to the top of the engine, both his legs being broken, and he was terribly burnt before he could be released from the wreckage, about five minutes after the collision. He died from his injuries about three hours afterwards."

And in relation to the block system, and the mode of working the traffic under it, he further observes :—

"Whether in this case the giving of the 'All clear' signal was or was not in accordance with the strict reading of the rule, I have no hesitation whatever in saying that, according to my judgment, no time should be lost in so altering the rules as to make it quite clear that, under no circumstances, should the 'All clear' signal be given for a second train to follow one which, as in this case, is standing only a few yards ahead of the home-signal, although clear of the actual block section. When block-working, or the preservation of an adequate interval of space between following or converging trains, was first instituted, it was, no doubt, the common practice to permit the giving of 'Line clear' immediately a train had passed the home-signal, or when shunting was going on close inside that signal, but experience showed that something more than a clear block section, from the starting-signal at one block cabin to the home-signal at the next, was necessary, and that some margin of safety must be provided for. The rule as to the conditions under which 'Line clear' or 'All clear' can be given (which is the essence of the system) varies very much. Upon some railways it is not allowed to be given until the first train is proceeding upon its journey, and has run a quarter of a mile beyond the home-signal ; upon others the margin is somewhat less ; upon others the line is cleared as soon as the train has passed the signal-cabin ; and upon one line at least there is a different 'clearing point' fixed for each station, inside the home-signal, varying in position according to the conditions of the line, and 'Line clear' is given if the line is clear as far as this 'clearing point.'"

That the burning of the vehicles was the result of the explosion of the gas is clearly proved by the evidence of the signalman, Harry Armstrong, which is as follows : "I saw the collision. The speed of the passenger train did not appear to have been slackened at all. There was a crash, and almost at once there was a flash like a flash of lightning, and the gas blazed up at once."

Edwin Hunt, another witness, in his evidence also testifies to the same effect. He says : "The moment after we struck the other train there was a flash like a flash of lightning, and a blaze of fire at once."

It was exceedingly fortunate that the burnt vehicles were empty. Had they been filled with passengers, there must unquestionably have been a large sacrifice of life, and that under circumstances of a most distressing character.

Dealing with a collision which occurred at Leeds on June 14th, between a light engine and a passenger train, in which, happily, but four passengers complained of injury, Major-General Hutchinson suggests "whether it would not be expedient to give the signalman in the station cabin electrical or mechanical control of the home signals, &c.," a recommendation which we hope may have been followed.

Major Yorke also, in reporting on a slight collision which occurred on the same line of railway at Kentish Town, on

October 31st, in which two trains were, by the omission of the signalman, in the same block section, observes:—

"This collision calls attention once more to the weak point in the present mode of block working, viz., that part of it which depends on the obedience of signalmen. Regulations of the most careful and satisfactory nature may be drawn up, but absolute compliance with them cannot at all times be ensured. The inference is, that though vast improvements have been made in late years in train signalling, a great deal remains to be done in order to secure immunity from such errors, whether due to wilfulness or carelessness, as that described above. . . . . And I would further suggest, for the consideration of the company, whether it would not be possible to adopt on busy sections of the line some system of electrical interlocking, which would prevent a signalman from lowering his starting signal without the permission of the man in the cabin next in advance. Had such a lock existed in the present case, the Kentish Town starting signal could not have been lowered for either train without the knowledge and permission of the signalman at Islip Street."

The terrible Thirsk accident, which occurred on the North Eastern line of railway on November 2nd, closes the list of these mishaps, the circumstances in relation to which have appeared to us to call for comment, or otherwise to bring them under the notice of our readers. The circumstances of this regretable instance are fully within the memory of all, for the case was one which produced much excitement at the time. The enquiry instituted by Major Marindin resulted, as is pretty well known, in a strong recommendation that railway companies generally should take into consideration the propriety of further protecting their traffic by interlocking the mechanical with the electric block signals—a proceeding which we have from time to time strongly advocated, and one which, sooner or later, must be adopted. We do not, however, quite follow Major Marindin entirely in his recommendation. The interlocking, whenever it is undertaken, must be complete. There must be no loophole. The clearance of the train must be for the complete train. Until the last vehicle has been cleared out of the section, it must remain blocked. There should be no difficulty in accomplishing this, and we hope soon to see one or more of our foremost lines bending their mind towards its attainment.

TRAIN LIGHTING IN AUSTRALIA.

AN interesting paper by Mr. Oswald Haes, has recently been read and discussed before the New South Wales Electric Club at Sydney on the subject of train lighting. Criticising the means hitherto in use for the purpose, the author proceeds to describe the system in operation on one of the New South Wales lines—a system which so closely resembles that which has been employed in England, by which the railway companies have sought to develop electric lighting for their trains, that it is quite unnecessary we should do more than refer to those parts in which a departure from this method has been made.

The dynamo employed is the Brush,* fig. 1, but instead of the sections of the commutator being used open, as is usual, Mr. Haes fills the spaces between these segments with mica, and employs copper gauze brushes arranged radially; the necessary pressure being obtained by spiral springs acting vertically on each brush. To meet the variation in speed, a framework in which the brushes are fixed is designed to admit of

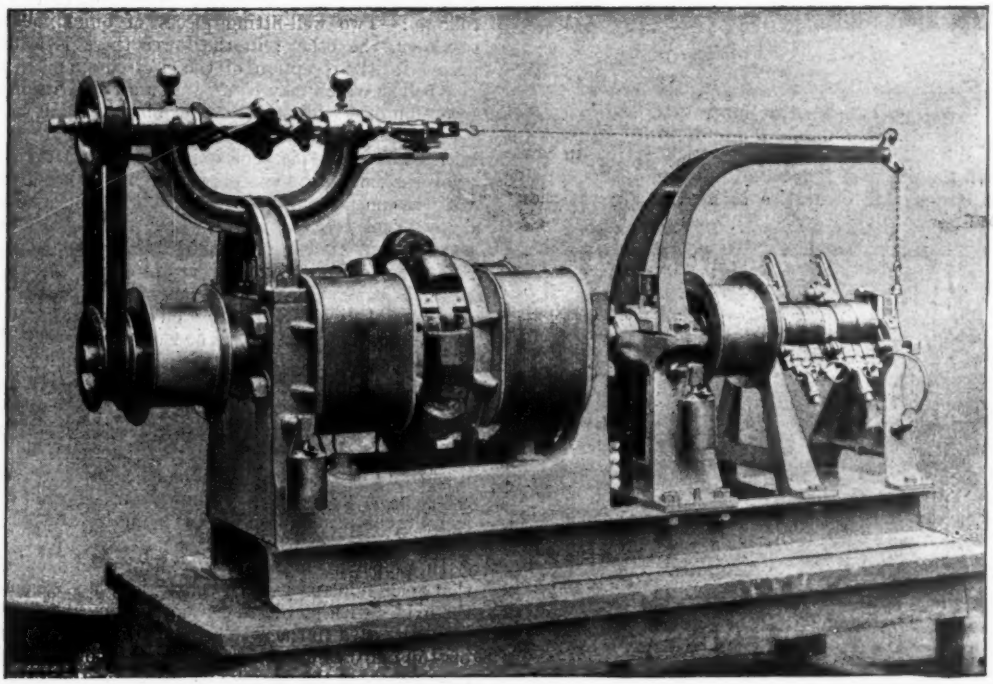


FIG. 1.—DYNAMO FOR TRAIN LIGHTING.

their being moved forward or backward according to the speed of the train under the influence of a centrifugal governor and a spiral spring, the one acting against the other upon a lever to which the brushes are attached. For reversing the direction of the current to meet the direction in which the vehicle is travelling, a lever, operating an ordinary reversing switch, is attached to the brush rocker and follows its action. When the dynamo shaft revolves in any one direction, the brushes and rocker are carried in the same direction, and the switch operated, and when the vehicle has attained the requisite speed, the circuit is closed in the usual manner. In the driving gear there is a modification of the practice pursued in England. The vehicle in which the dynamo is placed is a bogie brake, and as will be understood a departure from the English method was thus apparently unavoidable. Mr. Haes has met this by establishing a vertical drive of a somewhat compound character. A is a flanged pulley fixed to the axle of the bogie truck; B B, are flanged guide pulleys arranged to slide above the dynamo pulley in a vertical frame, fixed firmly to the floor of the van;

* This dynamo was described in our issue of May 27th, 1892.

C C, are spiral springs with their lower ends fixed to a cross framing. The pulleys, B B, are carried by the springs, and are adjustable by means of screws. The belt passes under the axle pulley, A, over the guide pulleys, B B, fig. 3, and under the dynamo pulley, D, fig. 2. Thus any deflection of the axle is met by the depression of one or other of the guide pulleys, the

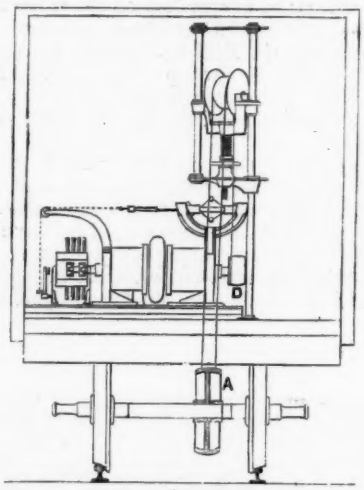


Fig. 2.—End View.

tension on the belt being maintained by the spring in connection with the pulley so influenced. It would also appear that these springs are of service in meeting any variation

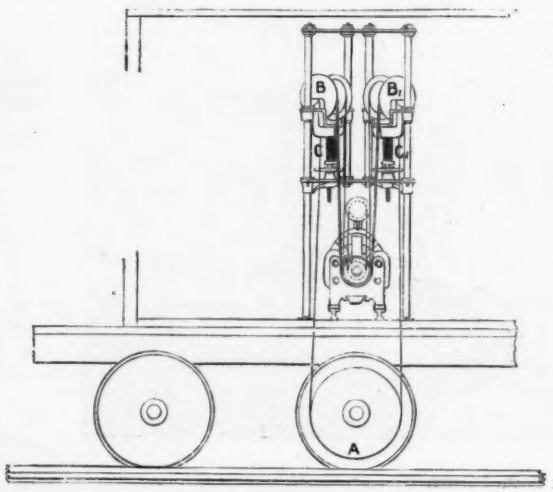


Fig. 3.—Side View.

there might otherwise be in the the tension of the belt, due to the springs of the vehicle. The entire arrangement is made quite clear by the figures, and it appears to have met with every success. We very heartily congratulate Mr. Haes on having overcome the bogie difficulty.

THE REDUCTION OF THE REFRACTORY EARTHS BY MEANS OF THE ELECTRIC FURNACE.

It is not often that the Paris Academy of Science is so fortunate as to have papers of real industrial importance read at their weekly *séances*. Holding a position in France very analogous to that of the Royal Society in England, the *Proceedings* of this ancient and renowned institution generally embrace accounts of researches into the domains of pure science, as it is called; and we believe that since the accumulation of scientific knowledge can usefully serve only one end, there would be much advantage accruing from a more persistent study of the commercial problems, the elucidation of which can be most rapidly effected by those to whom the term scientists may be strictly applied. It may be a very grand thing to devote years of research to the identification and description of obscure chemical substances, for example, but these are practical times, and we submit that more immediate good might be accomplished by applying systematised investigations to the great national industries.

In the Electrical Review for March 10th, an account is given of the electric furnace which has been devised by MM. Ducretet and Lejeune, and in this connection may be usefully considered the recent researches of Mons. Moissan. This scientist, who is chiefly known to the general public for his production of artificial diamonds a few years ago, has recently communicated three memoirs to the proceedings of the Paris Academy of Science upon the manufacture of the refractory metals.

It goes without saying, that the means which have rendered this possible are electrical. The special form of electrical furnace in which the reduction of the ores or oxides is effected was described by Mons. Moissan in a paper read before the Paris Academy on December 12th, 1892 (*vide Comptes Rendus*, cxv., No. 24, December 12th, page 1,031). It differs somewhat in plan from the laboratory furnace of MM. Ducretet and Lejeune, and consists essentially as follows:—Two well-fitting pieces of quicklime are placed one upon the other; in the lower there is a longitudinal groove for the reception of the electrodes, and in the centre is a hollow which may be used as a crucible itself, or for the reception of a retort carbon crucible in which is placed the earth to be reduced. If large quantities are to be dealt with, the upper piece of quicklime is perforated, so that small cartridges of a compressed mixture of the ore or oxide with carbon powder may be added from time to time. The diameter of the electrodes, which are also of carbon (and become converted into graphite during their use), is varied according to the strength of current employed.

In the cavity a quantity of magnesia is placed, upon which the crucible rests; this substance is practically unaffected by the high temperature of the electric arc when the furnace is in action. If the metal that is to be produced is volatile, a current of hydrogen is kept passing through the furnace and a cooled receiver is provided, in which the metal is condensed.

Success has attended the experiments with the metals strontium, barium, and calcium—the metals of the alkaline earths as they are called, and now Mons. Moissan can produce metallic chromium, uranium and manganese from their respective oxides.

In preparing uranium, the metal whose oxides produce that splendid canary-green colour in glass, &c., a mixture of the oxides with powdered carbon is rammed into the crucible, and submitted to the action of an arc produced by a current of 450 ampères 60 volts. In a very short time the oxides are reduced to the metallic condition by the reducing action of the carbon at the high temperature of the arc, and a solid ingot is obtained.

The protoxide is used as the source of the metal manganese. It is mixed with powdered carbon, as in the previous case, but the current required is only 300 ampères 60 volts. If the action be prolonged, say, to 10 or 15 minutes, the current may be reduced to 100 ampères 50 volts.

Chromium—a much more difficult metal to extract by the processes hitherto in vogue, readily yields, under similar conditions, to the action of an arc produced by a current of 350 ampères 50 volts, but if the time of action be prolonged to half-an-hour, a current of 30 ampères 50 volts is found to be sufficient to effect the reduction. The sesquioxide is most conveniently employed, but Mons. Moissan has succeeded in producing a (probably) useful iron-alloy from raw chrome iron ore.

There is one difficulty about the metals which are produced in this way, and that is their contamination with carbon. An excess of powdered carbon appears to be a necessary condition, and this involves the production of metallic carbides. This is obviously a difficulty which will be made to disappear when Mons. Moissan has brought his experience to bear upon it. A ready method of refining the crude ingots ought not to be out of the question.

The two papers dealing with this investigation are given in full in the *Comptes Rendus*, Vol. cxvi., No. 8 (February

20th, 1893), pages 347 and 349, where further details will be found. We may notice, however, that the experiments were carried out at the Conservatoire des Arts et Métiers. No particulars are given of the dynamo employed, but in the earlier experiments a small Edison machine was used and driven by a gas engine.

TEST OF AN 100-H.P. GAS ENGINE.

THE current number of the *Journal* of the Franklin Institute contains an account by Mr. H. W. Spangler of a gas engine test made with producer gas.

The engine tested was one made by the American makers of the Otto engine, and was peculiar in construction, having two cylinders one above the other, the upper connecting rod taking hold of the crank pin, and the lower one being connected near the crank pin end of the upper connecting rod.

The cylinders were $14\frac{4}{8}$ inches diameter and 25 inches stroke, and the mean clearance volumes 27·96 per cent., the speed being a trifle over 160 per minute throughout the three days' test, and the number of explosions 157·57, the latter figure we may suppose applying to the sum of the explosions in the two cylinders. The whole of the results are given with a fulness which seems to us excessive for publication in the Institute's *Journal*, Table I., for example, containing the reading at each 10 minutes' intervals all day through on three days of the revolution counter, explosion counter, pyrometer, gas pressure, brake lever load, &c. Surely the mean of these would have been amply sufficient.

The total time run is not the actual time, for it was deduced from the number of explosions as observed after these had become uniform and the load steady. The average brake horse-power for the test was 92·49. It appears that during the preliminary tests the indicators would not work, either the springs or the pencil bar being broken by the violence of the explosion.

Finally it was necessary to use a Thomson indicator with a piston of $\frac{1}{4}$ of a square inch area only, and this indicator had to be moved every time a card was taken and again applied for the next card, because "*the heat conducted from the cylinder was sufficient to melt the solder holding the spring to the screw ends.*" We italicise this remarkable statement, because it affords so striking an illustration of the immense distance which separates much of American mechanical work from American professions of immeasurable superiority of all things American. We do not mean to say that all English makers of steam engine indicators avoid solder upon their springs, but we have before us as we write the springs of an English maker—Casartelli, of Manchester—and there is no solder on them. We believe also that Schaffer and Budenberg, the German makers, use no solder. We have used their indicator on gas engine tests, and not moved it for some hours, and experienced no bad results, and it was only a few days ago that we saw one of the leading American indicators, new instruments in which all the springs were plastered up with solder. This by the way, however.

The mean I.H.P. was 127·7, the mechanical efficiency being thus remarkably small, a fact which is attributed to the newness of the engine, but which we ourselves are inclined to think would be found to exist with most gas engines, the heat of the cylinder probably having much to do with this. The results are summarised as follows, and these figures may apparently be taken as fairly representative of producer gas results. They are given in thermal units :—

Heat in 1 lb. of coal	...	14,117·818
„ „ produced gas	...	9,756·79

giving a producer efficiency of 69·1, a figure which is not in excess of that of a good steam boiler.

Heat units available per explosion	...	125·76
„ „ used „ „	...	124·08

showing an efficiency in the cylinder of 98·7 per cent. Of the heat produced the following account is rendered :

In the exhaust 34·721 ; to the water jacket 38·005 ; a sad waste of heat this, though there seems no way of avoiding it as yet.

Heat converted into power 34·375, and heat unaccounted for 16·98, which latter is explained as having been partly expended in putting the producer in motion, and the pyrometer was also thought to have shown too low an exhaust temperature ; this being 752·81, quite high enough, however, to the mind of a steam engineer.

No doubt, also, radiation makes up a fair share of the missing 16·98 per cent.

Taking the heat turned into I.H.P., the efficiency of transformation comes out at 27·7 per cent.

The mechanical efficiency at 72·4 per cent., and the total efficiency of the plant 13·66 per cent., corresponding with a coal consumption of ·9511 lbs. per hour per I.H.P., and 1·315 lbs. per brake horse-power, a better showing probably than has been yet given by any steam engine.

The combustible used works out at ·8302 and 1·148 lbs. per indicated and brake horse-power respectively. Even with the low mechanical efficiency, the results cannot be considered at all unfavourable for producer gas, and should please Mr. Dowson.

The analysis by weight of the gas gives the following :—

CO_2	...	6·50
O	...	0·23
CO	...	26·03
H	...	0·33
CH_4	...	1·05
N	...	65·81
		100·00

The analysis of the exhaust is as follows :

CO_2	...	49·65
O	...	5·18
CO	...	·49
H_2O	...	5·38
N	...	165·94
		226·64

showing that 126·64 per cent. of air had been added to render the producer gas explosive, and had resulted in the almost complete oxidation of the carbonic oxide, the disappearance of the little marsh gas, and a slight addition to the free oxygen proving an excess of air admitted.

The analysis of the coal fed to the producer gave a carbon percentage of 80·41 and 6·88 of combustible hydrogen and marsh gas. The total carbon, including that in the 5·8 per cent. of marsh gas, was 84·76, and the percentage of ash and moisture was 12·71, a pretty large amount, hence the reduction of the fuel consumption per horse-power by the bringing in of that blessed word "combustible," which is so serviceable in all such tests in bringing results more into accordance with hopes than they appear when worked out direct from common coal.

During the test the explosion was effected by an electric spark, so obviating the necessity for making allowance for the gas used for explosion. We wonder how often gas engine makers include this little (?) tube-heating furnace in their published statements of gas consumption ? Some of these external flames appear remarkably liberal in their volume.

The producer was worked by a positive air blower, the air being passed through a wet coke scrubber, and the steam was produced by the heat carried from the fuel bed by the gas itself, no separate boiler being required. To work the air blower required ·085 horse-power for 1 inch water gauge, and ·431 for $9\frac{1}{4}$ inches gauge. This should, properly, be subtracted from the commercial power of the engine, but does not appear to have been so debited against it further than by simple statement of the fact.

We may conclude from the gas analysis that the chief part of the 31 per cent. loss in the process of gas production is that due to the heat developed in the manufacture of the carbonic oxide, which amounts, roughly, to a third of the total heat of combustion of carbon, and would be dissipated by radiation from the scrubbers and gas holder. In the engine itself, the water jacket, of course, causes immense loss, and there seems to be a field for the reduction of the exhaust temperature or its utilisation in some way.

Fleetwood Electric Lighting.—The Electric Lighting Committee are arranging to visit several towns for the purpose of inspecting the electric light installations.

D

CHEAP TRACTION OR DEFECTIVE TELEPHONES.

On April 26th, 1893, a meeting was held at the Board of Trade, Sir Courtenay Boyle, K.C.B., in the chair (Sir Joseph Warner, counsel to the Lord Chairman of Committees being present) at which the Telephone Company and the Electrical Traction Association were represented.

The Telephone Company put it to the Board of Trade that inasmuch as during the past four years they had opposed some 50 Bills in Parliament, with the result that with one or two unimportant exceptions clauses for their protection had been invariably given, either in the form adopted in 1889 in the Lea Bridge case, or in 1890, in the Plymouth case, the time had now arrived when the Board of Trade should accept one of these clauses as a model clause, and take measures to ensure the insertion of such clauses in all Electrical Traction Bills, and Orders without further action on the part of the Telephone Company.

The essential portion of the Plymouth and Lea Bridge clauses is the first paragraph as follows :—

1. The company shall so construct their electric circuits and other works of all descriptions, and shall so work their tramway in all respects as to prevent any injurious interference by induction or otherwise with the electric circuits from time to time used or intended to be used by the Telephone Company for the purpose of telephonic communication or with the currents in such circuits. Provided that as regards electric circuits erected or laid down by the Telephone Company after the construction of the works of the company this sub-section shall only apply if reasonable and proper precautions have been taken in the erection or laying down of such circuits, and if they have not been erected or laid down in unreasonably close proximity to the lines or works of the company.

Sir Courtenay Boyle, having heard the representatives of the Traction Association, intimated that the Board of Trade were of opinion that what had taken place *did not* amount to the establishment of an uniform principle that there should be protective clauses in favour of the Telephone Company.

He thought that since 1889 a good deal of knowledge had been gained, and that the Board of Trade would now communicate with the authorities of Parliament to see whether the matter could be considered and settled, and that in the meantime the Board of Trade would not insert any protection clauses in favour of the Telephone Company.

As an outcome of these communications, a resolution for the appointment of a Joint Committee of Lords and Commons has been passed by Parliament, "to consider and report whether the grant of statutory powers to use electricity ought to be qualified by any prohibition or restriction as to earth return circuits, or by any provisions as to leakage induction or similar matters, and if so, in what cases and under what conditions."

"And if the Joint Committee are of opinion that any such prohibition, restriction or provision should be enforced, to settle the necessary clauses."

The question for consideration by the Joint Committee is in effect whether the Telephone Company is to have *its present system* protected or not.

The form of reference does not at first seem to mean this, but it must be borne in mind that the Telephone Company are at present carrying on their business without statutory authority, and that (save by a general Act) Parliament can only legislate by the insertion of clauses into Bills or orders brought before them by promoters asking for powers to use electric traction.

When this Joint Committee meets, it is assumed that the whole question of electrical traction and telephones will be considered, and the committee will either give the Telephone Company the protection for which they ask, or say that any protection shall be conditional upon the Telephone Company amending or altering its system by the introduction of a metallic return or otherwise.

The Telephone Company allege that they have always obtained protection clauses from Parliament since they commenced opposition to those Bills in 1889.

This is not quite accurate.

Out of 50 cases protective clauses were inserted in about 40 cases *by consent* (given no doubt in many cases to save the heavy expense of a long Parliamentary fight) and it was only in about 10 cases that the matter came before the Committee.

In the cases fought the results were by no means uniformly favourable to the Telephone Company.

The evidence given by the Telephone Company may be summarised as follows :—

The Telephone Company first showed that the currents used by the Telephone Company were infinitesimal and not likely to do any harm to anybody else.

That it was *cheaper* to them to dispense with a metallic return and to take the current back by means of gas pipes or otherwise by earth returns.

That telephones had been decided to be within the terms of the Telegraph Act, and that in consequence telephonic messages being telegrams, were only a branch of a business which had for 50 years been carried on by means of earth returns, and therefore obtained a prescriptive right to the use of the earth.

That the Electrical Traction Companies quite recently proposed to use earth returns.

That the currents required for electric traction were very large and powerful.

That leakage from or the inductive effects of these currents passing interfered greatly with the telephones.

That the Telephone Company's lines could be protected from interference by using a metallic return and twisting the wires.

That such steps could, however, only be carried out at enormous and prohibitive cost.

That on the other hand it is very simple and inexpensive to prevent interference by insulating the conductors used for electrical traction.

The evidence upon which the Telephone Company have heretofore succeeded in obtaining protective clauses, will show that the real facts of the case have never been fairly put forward, for it was to the following effect

That the same rules should be placed upon electric tramway cases that had been placed upon the electric lighting companies;

That prevention of leakage to earth was solely a question of expense;

That it was perfectly easy to insulate the two conductors in a conduit at an expense of about £40 per mile, whereas to lay down a metallic return to telephone wires would cost an enormous amount.

But electric traction cannot be governed by the rules placed upon electric light; for while nothing is easier than the insulation of electric light conductors from which the current is taken at fixed terminals, nothing is more difficult than the insulation of electric traction conductors where the current is taken by the arm of a passing tramcar.

In the Folkestone case, where the cost of insulating the tramway conductors was put at £40 per mile, the decision of the committee was that if the Telephone Company required this done, they must themselves pay for it; but the Telephone Company showed their faith in their witness's estimates by refusing the clause, and allowing the Bill to pass without any protection to them.

As a consequence they had to pay the promoters' costs, amounting probably to more than the cost (on their estimate) of insulating the tramway conductors.

The telephone service with earth returns is admittedly defective.

The use of a metallic return by the Telephone Company is not only possible, but would, it is admitted, prevent all interference, and the only excuse given by the Telephone Company for their failure to make their system perfect by this means is that of expense.

On the other hand, it has been shown that the use of electricity as a motive power reduces greatly the necessary cost of tramways, but that in practice it is not possible to insulate the conductors.

The matter resolves itself into the question whether *cheap traction* is to be prohibited in order that a *defective telephone* system may be maintained, or whether the *Telephone* Company should not be compelled to perfect its system, and by that means take away the reproach that its service is not only bad, but retards the due progress of other electrical industries.

And this is the real question that will have to be submitted to the Joint Committee.

Primâ facie, it may seem that there can be little doubt that the decision will be in favour of the traction interest.

But in view of the strong position occupied by the Telephone Company, it behoves all Corporations and local authorities, and all those who desire to see *cheap traction* encouraged and the telephone service improved, to support in every possible way the Electrical Traction Association before the Joint Committee.

R. E. CROMPTON.
E. GARCKE.
SYDNEY MORSE.

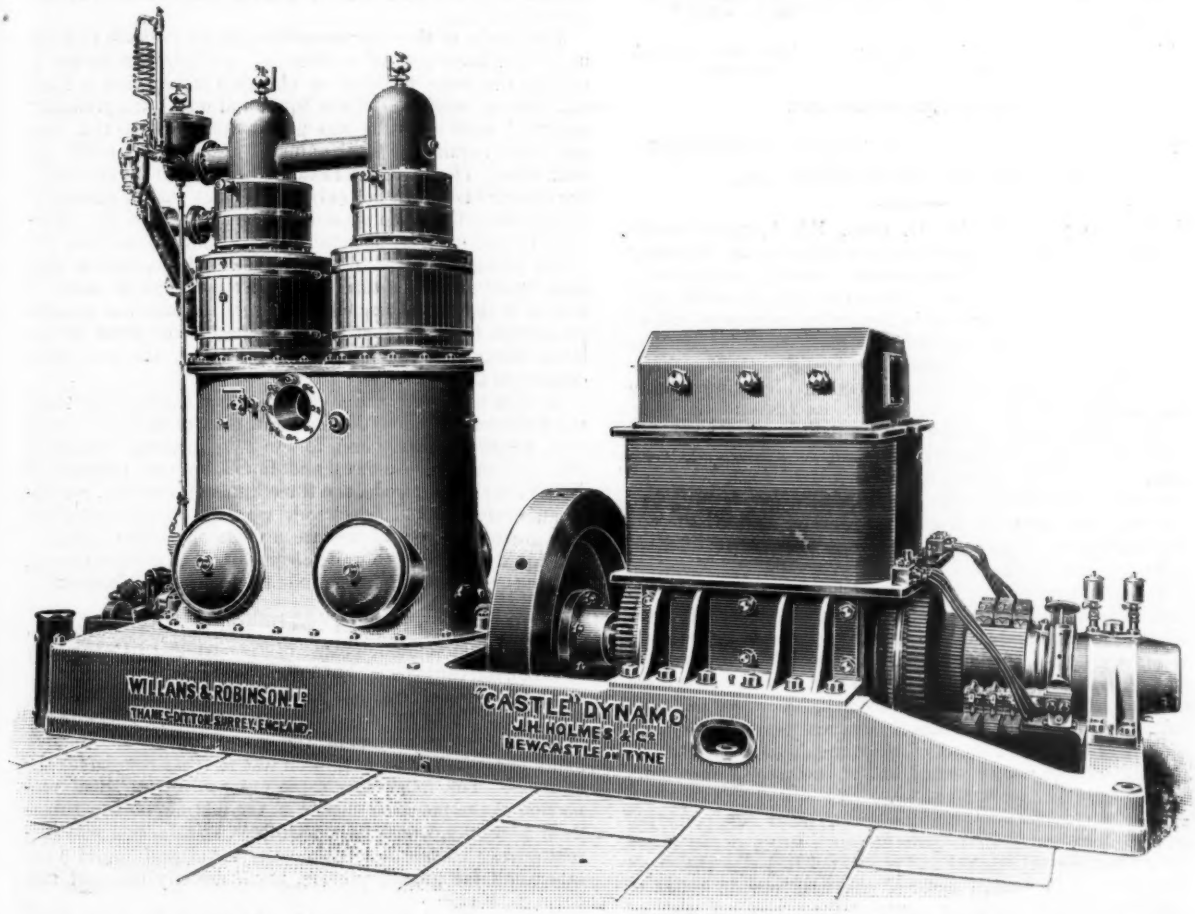
TESTS OF A CASTLE DYNAMO AND WILLANS ENGINE.

MESSRS. J. H. HOLMES & CO., of Newcastle, have just completed a large "Castle" dynamo, which possesses some special features, embodying latest improvements, and illustrating how near perfection the design and construction of such machines has arrived. The dynamo has been coupled to a Willans patent central valve engine, size I I, compound, and is now at the works of the makers of the engine, Messrs. Willans and Robinson, at Thames Ditton. Here the combination has been submitted to tests during a six hours' run each, the results of which we give below. It will be seen that the results of temperature tests in both cases are remarkably good. Great care was taken in the construction of the dynamo, both by keeping the density of the conductors small and by eliminating Foucault currents, to ensure the temperature of the machine after lengthened runs being as low as possible; the purpose for which the machine is supplied necessitating that it shall be run for a period of nine months night and day. The space occupied by the machine is exceptionally small, namely, 13 feet by 5 feet over all.

The dynamo is of the drum armature type, wound with bar conductors, and is designed for an output of 125 volts, 1,025 ampères, at a speed of 350 revolutions per minute, thus being capable of supplying current to more than 4,000 lamps of 8 C.P. each. The armature alone weighs considerably over 2 tons, and has a core built up of about 1,700 thin Swedish charcoal iron discs, carefully insulated from each other by specially made parchment paper of unusual thinness. The discs are mounted directly upon a steel shaft, and are driven by a key running the entire length of the core, and they are notched in such a manner as to leave three ventilating spaces next to the spindle. The bar conductors are built up of copper strips so split up and twisted as to prevent as much as possible the formation of "eddy" currents, and they are driven in a positive manner from the core by means of drivers which rest in channels at intervals round the periphery; the end crossings or connections are made of copper strips of ample cross-section, and without joints, arranged in a compact form at each end of the armature, without however interfering with the efficient ventilation of the core through the channels described above.

The field magnets are of best annealed iron forgings machined all over, and weigh with their copper winding about 8 tons. These forgings rest upon a brass bed lying on a concrete foundation, and are steadied at the sides by non-magnetic brackets fastened to the Willans patent combination frame forming the base of the engine and carrying the outer bearing of the armature. The Brush holders are of massive proportion, suited to the large currents they have to convey, and the connections between the armature and the commutator are so arranged as to bring the line of commutation into the horizontal plane, with the object of making the brushes and holders more easily accessible.

The magnets are plain shunt wound, and the resistance of the coil is such that at full load about 15 ampères of current flows around the magnets, being therefore rather less than 1½ per cent. of the current in the external circuit.



All the latest improvements are introduced into this machine, the builders' aim being to combine thorough mechanical design with high electrical efficiency, the latter said to be over 97 per cent., so that deducting friction and other losses, there is claimed a net commercial efficiency of at least 94 per cent., and this is maintained over prolonged runs.

The efficiency of the combined plant, that is to say, the ratio of the electrical horse-power in the external circuit, to the indicated horse-power in the cylinders of the engine at full load, was actually found to be over 86 per cent. during tests recently made at the works of the engine makers.

After the engine has been run for a few months, it is believed that the efficiency will reach as high as 87 per cent. or over.

RESULTS OF TESTS BY F. V. ANDERSEN, ESQ., MAY 12TH, 1893.

Results of Indicating—Mean pressure :—

High pressure cylinder actual = 32·76, reduced for L.P. area	= 15·96
Receiver actual = 8·68, reduced for L.P. area	= 3·89
Low pressure cylinder	= 25·52
Total	45·37

Mean speed 335·7 revolutions per minute.
Low pressure piston area = 290·4 square inches.
Stroke, 9 inches. Two lines of cylinders.

$$\text{Indicated H.P.} = \frac{335{\cdot}7 \times 290{\cdot}4 \times 1{\cdot}5 \times 45{\cdot}37}{33{,}000} = 201{\cdot}07.$$

Volts at terminals of dynamos, 128·3.
Ampères in external circuit, 1,006.

$$\text{Electrical H.P.} = \frac{128{\cdot}3 \times 1{,}006}{746} = 173{\cdot}0.$$

$$\text{Combined efficiency} \frac{\text{E.H.P}}{\text{I.H.P.}} = \frac{173}{201{\cdot}07} = 86{\cdot}04 \text{ per cent.}$$

Results of Weighing Steam—
1,400 lbs. of steam were condensed in 22 mins. 25 secs., which is equivalent to 3,747 lbs. per hour.

$$\text{Steam used per E.H.P. per hour} = \frac{3{,}747}{173} = 21{\cdot}66 \text{ lbs.}$$

Results of Temperature Tests—
Temperature of armature at start, 29·5° Centigrade.
Do. after six hours run at full load = 57° Centigrade.
Rise = 27·5.
Temperature of room at start = 23·3° Centigrade.
Do. do. finish = 26·0° Centigrade.

Difference = 2·7

Therefore the actual rise in armature due to running of the machine was 27·5 — 2·7 = 24·8° Centigrade = 44·7°* Fahrenheit.

We are informed that exhaustive tests have been made by Prof. Kennedy, which practically confirm those of Mr. Andersen.

RELATION OF VOLTA ELECTROMOTIVE FORCE TO PRESSURE, &c.

Forty-two years ago Dr. G. Gore, F.R.S., made several experimental attempts to discover a difference of molecular state in the upper and lower ends of a vertical column of a solution of cupric sulphate. These attempts, however, were not successful, owing to certain disturbing influences, and to the employment of an insufficiently sensitive galvanometer. Recently Dr. Gore has renewed the experiments in a somewhat different form, and has succeeded in obtaining definite though small effects.

The arrangement usually employed was as follows:—A single glass tube (or several) about 3 metres long and 1 cm. bore, securely fixed upon a board, was fitted with corks and two wire electrodes of the same kind of metal at its two ends; it was then filled within ·5 cm. with an electrolyte. The bubble of air receded into a small branch tube, situated half-way between the two ends, when the tube was placed in a horizontal position. The two electrodes were then connected with a Thomson's reflecting galvanometer of 3,040 ohms resistance, and the tube allowed to remain undisturbed until all sign of current or of variation of current ceased. It was then placed in a vertical position, and as soon as a steady permanent deflection occurred, its direction and amount were noted, after which the tube was again placed either horizontal, until all current ceased, or at once placed vertical with its ends reversed, and the amount of maximum steady deflection again recorded.

Several modifications of this arrangement were employed by Dr. Gore, and in some cases five such tubes as the above were fixed upon the board and connected in series, the upper electrode of one to the lower of the next one, in order to multiply the effect, and as many of them charged with an electrolyte and connected with the galvanometer as desired. By employing suitable metals and electrolytes, making each pair of contiguous parts of the same piece, and including in each instance a wire coil of 50,000 ohms resistance in the circuit, the fluctuations of the current were reduced to a minimum, and the needles usually settled at or near zero in about five or ten minutes after closing the circuit with the tubes in a horizontal position. No perceptible amount of interference was caused by the small difference of temperature usually equal to about 1·5° C. of the upper and lower parts of the experimental room.

The paper in which the results of this investigation are given has been reprinted from the *Philosophical Magazine*, and occupies about 15 pages. Dr. Gore has kindly sent us a copy. These results are set out with a characteristic regard for even the *minutiæ* of the experiments.

The first list of tabulated results deals with 88 experiments on the effect of varying the electrolyte only; electrodes of zinc being used. Next, the effect of varying the electrodes and the liquids is considered. The degree of permanence and of the E.M.F. of the currents, and the influence of the strength of the solution, is examined, and some experiments are described, which were undertaken with the view of determining the influence of equal pressure at the two electrodes, the influence of difference of pressure without difference of altitude, and the influence of thermo-electric action.

The currents were manifestly occasioned by difference of pressure at the upper and lower electrodes, and apparently by that circumstance alone. They were not due to the unequal temperature of the room, nor to heat evolved by the pressure at the lower electrode, nor to air or impurities dissolved in the liquids, nor to bubbles of gas, &c., adhering to the electrodes, nor to greater conduction resistance of the electrolyte in a downward than in an upward direction, nor to difference of altitude of the electrodes, except so far as it affected the pressure; nor were the deflections caused by mechanical disturbances of the galvanometer nor by any magnetic substance near it. They were also not produced by thermo-electric action due to greater chemical heat at the lower electrode.

The results of the experiments in general indicate that the upper and lower ends of a column of an electrolyte are not in exactly the same physical or chemical state; that a fixed difference of condition of the liquid and metal was gradually produced when the tube was placed vertical, and that this condition required several minutes in order to attain its maximum. That both the metal and the liquid are altered by the pressure is shown not only by the fact that a change of either affects the amount (and, in some cases, also the direction) of the current, but also by the circumstance that the period of time required to reverse the condition, and the current, by reversing the tube varies with a change of metal as well as of liquid. These circumstances indicate the gradual production by pressure of a state of mechanical stress of the lower electrode and of the liquid near it, the one being counter to the other.

As this increase of pressure and stress at the lower electrode was followed by the production of a permanent electric current, it must also have been followed by increased energy of chemical union of the metal and liquid, and an increase of E.M.F. at that electrode, the three kinds of pressure, mechanical, chemical, and electrical, varying directly together. The greater mechanical pressure at the lower electrode enabled the liquid and metal to unite chemically with greater energy, and thus permitted that electrode to become electro-positive to the other.

The phenomena suggest some abstruse questions, *e.g.*, What is the most hidden cause of the current? Only a very fundamental cause could have produced so large a proportion as 95 per cent. of currents in one uniform direction. Dr. Gore thinks that the original cause must lie in some change of the potential motion of the molecules; some kind of molecular energy must have been lost in order to produce the currents. The immediate cause was probably a small proportion of the potential energy of the motion of the superficial molecules, which must have been transformed into current during chemical union of the metal and liquid; the other, and far greater portion, being directly changed into chemical heat.

The questions why one portion is directly converted into electric current and another into heat, and why so largely into heat, have not been examined by Dr. Gore.

We know that work is done during the act of putting on the pressure, and that this work may increase the energy of molecular motion; in addition to the energy communicated to the arrangement in this way, constant pressure may produce constant current if there is a continual yielding of the molecules to it; but as only motion can produce motion, and as unchanging pressure is a purely statical phenomenon, if there is no such yielding, unvarying pressure cannot be a real cause of continuous current. We know, also, that the properties of substance and the molecular motions to which those properties are due, vary with every change of mechanical pressure. If, therefore, pressure alters the direction or the velocity of molecular motion, it may act as a permitting condition so as to enable some of the unceasing motion of the molecules to expend itself in producing a per-

* This should be 76·6° Fahrenheit.—Eds.

manent current, like such motion does in a voltaic cell; and this appears to be a reasonable explanation. Contraction of total volume by chemical union, being a yielding to pressure, may contribute to the result in the present case.

The production of current must have been as much dependent upon the pressure and the state of molecular motion at one electrode as upon the other, and it is known that volta E.M.F. is very intimately connected with velocity of the molecules, and that the two appear to vary directly together (*vide Proc. Birm. Phil. Soc.*, 1892, Vol. viii., pp. 63—138. The ELECTRICAL REVIEW, Vol. xxx., pp. 693, 722, 755, 786, and the *Phil. Mag.*, Sept. 1892, p. 307), hence it is probable that the greater degree of pressure at the lower electrode permits some of the molecules of liquid and metal to strike each other with greater velocity than at the upper one. Now pressure has the same effect as dilution of the electrolyte upon volta E.M.F.; and as dilution is apparently attended by an increase of velocity of the molecules, it is reasonable to conclude that pressure is probably attended by a similar result. As far as can be judged from the present results, E.M.F. seems to be due to unequal molecular pressure.

Dr. Gore suggests the investigation of the relations of the current to the compressibility and elasticity of metals and electrolytes; also the investigation of the effect of pressure upon the electric potential of the metal alone, and upon the electrolyte alone. He predicts that the latter would probably show that pressure increases the positive potential of positive substances, and the negative potential of negative ones. He also mentions a number of side questions which presented themselves during the course of his research, and concludes his paper with a discussion of the effect of pressure on voltaic couples. This we have noticed elsewhere.

NOTES.

Obituary.—By the death of Mr. E. A. Cowper, which we deeply regret having to announce, the engineering world has lost one of its foremost and oldest representatives. Mr. Cowper's death occurred very suddenly on 9th inst. from the effects of a chill, which developed into pneumonia. He was in his 73rd year. The results of his remarkable inventive genius are so well known to engineers, that it is needless to enumerate the various inventions here. We merely mention the production, in 1879, of his ingenious writing telegraph, which he exhibited before the Institution of Electrical Engineers and the Royal Society. His early advocacy of the compound engine, and the improvements effected by him in engine working generally, cannot be easily forgotten. At an earlier period of his career he was an associate of Sir William Siemens; he was also a member of nearly all the English technical institutions, but more particularly will he be remembered for having so ably assisted in founding an Institution which has since extended to such large dimensions, *i.e.*, the Institution of Mechanical Engineers, which task was accomplished in 1847. The many honours conferred upon him by various bodies are in themselves evidence of how highly he was esteemed by the members of his profession. His death is especially touching, as, beginning to feel the effect of his 73 years, he had decided that he must partly retire from his usual business activity, and have comparative rest for the remainder of his life. With that object in view, he had recently taken his son, Mr. Charles E. Cowper, who had been assisting him for many years, into partnership.

Cable Communications.—The following are the repairs to submarine cables, which have been effected during the week ending 23rd inst.:—Para-Maranham cable repaired May 21st, 1893.

The Queensland Telegraphs.—At a smoking concert recently held at Brisbane, a presentation of an illuminated address and a cheque, was made to Mr. A. F. Matveieff, late superintendent of the Queensland Telegraphs. Mr. Matveieff, who has recently retired, has been connected with the Queensland Civil Service for over 32 years. He is succeeded in his post by Mr. J. M'Donnell, who is also Under-Secretary.

Electrical Work at Chatham Dockyard.—A return has been called for by the Admiralty of the annual salaries and pay to officers and men employed on electrical work at Chatham Dockyard.

Portsmouth Electric Lighting.—The Portsmouth Corporation have intimated that they hope in the autumn to be able to supply electric energy to private consumers for lighting, heating, and ventilating purposes, at the rate of 6d. per Board of Trade unit.

Cost of Power by Oil Engines.—Prof. Ayrton has recently stated that the consumption of oil in a Priestman oil engine of medium size averages 1 lb. per brake horse-power hour. At current prices, and with the class of oils which are suitable for use in the engine, this means that the cost of an actual horse-power for an hour does not exceed ½d. It is only on the basis of some figures like these that a comparison between the cost of extraneous supply and private generation can be based. Although the supply companies are careful to do their utmost to reduce the price of electricity from time to time, they are handicapped by the expenses of the requisite powers, charges for management, and cost of distribution, and there seems to be a large field in which the balance of favour would lie with an economically operated private plant where gas or oil engines could be used.

Early Lamp Experiments of Mr. Edison. — Simultaneously with the publication of the second lamp case, in which "Goebel defence" was used, the *Electrical World* publishes two articles under the title of "The Story of the Evolution of the Edison Incandescent Lamp." The account which is given is based on one of the affidavits presented in the case referred to, viz., that by Mr. Wm. J. Hammer, who, in very early days, was employed in Mr. Edison's laboratory. Mr. Hammer has preserved a number of specimen lamps which were constructed at different epochs, and as he was so intimately connected with their production, his testimony on this interesting subject may naturally be depended on. The articles in question are rendered all the more attractive by excellent illustrations of the collection of specimens. We can do no more here than refer to one or two points of special interest that are brought out. Specimen I. shows Edison's early platinum iridium thermo-static regulator lamp, the spiral incandescent wire being supported inside a short, wide-necked glass cylinder. Another device shown is similar in form, but a number of parallel strips of platinum foil constitute the light-giving agent. These arrangements were made in 1878. A third device is the oxide of zircon lamp, consisting of platinum iridium wire coiled round a piece of pipe-clay, the wire being subsequently painted over with the earthy oxide. This burner is supported inside a rather narrow glass tube. Next in order comes the great step in advance of enclosing a platinum wire spiral in quite a modern-shaped lamp bulb, from which the air has been exhausted (similar in all essential respects to Crookes's apparatus, made and used several years previously, which was, however, not devised for the same purpose). This modification was made early in 1879, and was followed late in the same year by the substitution of the wire by the horse-shoe of carbonised paper. In both these lamps the leading-in wires are sealed into short lengths of glass tube let into the neck of the bulb, on the principle still adhered to in the Edison lamp. Some of the succeeding carbon burners were enclosed in comparatively large bulbs, as it was imagined at the time that the lamps would thereby last longer. Platinum clamps were used in these early lamps to support the filaments. Another feature about them was a long pipe at the part separated from the exhaust tube, the object being on account of the belief that air leaked into the bulb at the seal, and was hindered by the length. Then came lamps with bamboo filaments, supported by nickel clamps, the bulbs being lengthened. These were made in the fall of 1880. Next, silver-plated joints between the carbon and platinum wire were tried, but this did not answer well, as the silver volatilised and darkened the bulbs. These lamps were made in January, 1881, and were soon followed by copper-plated joints, which method was employed for a long time. Since that time the modifications that have been made in the lamp have been almost exclusively in slight matters of detail and in methods of working.

French Transformers.—Mons. G. Roux gives some tests in *L'Industrie Electrique* of the Labour type of transformer, as he is desirous of establishing the equality of the French made article with those of English and other makes. They show an efficiency of about 95 per cent. at full load for an 8,000-watt transformer, and from the table given, it would appear that the designer has been successful in getting the sharp rise in the efficiency curve, so essential for economical supply.

Monopoly of the Use of Salts of Lead.—On the 5th inst. the Paris Court of Appeal has decided that the four patents granted to Camille Faure give him the absolute monopoly of the use of lead salts and oxides in the construction of secondary batteries, and that anyone who uses such materials for the purpose of making electrodes for secondary batteries infringes the above-said patents. This is an old claim, several times mentioned in the London electrical press years ago, but whoever could have supposed that such a pretension would have been supported by law courts?

Electric Lighting of Railway Carriages. — The Paris-Lyons-Mediterranean company has just decided, after many experiments, upon lighting by electricity 50 first-class carriages, each divided into four compartments. Each carriage will be provided with a battery of multitubular Tommasi accumulators of 12 elements connected in series. Each element will contain 12 kilogrammes of electrodes. The battery will be divided into four groups of three elements, and each group will be placed in a case divided into three compartments. Each case will in its turn be placed in a sheet-iron coffer lined with wood. These coffers are fixed to the sides of the carriage. Connections are arranged so that the accumulators are grouped in circuit automatically as soon as they are placed in the coffer. The accumulators are connected with the lamps placed in the carriages by means of insulated cables. Each circuit comprises a lighting commutator, an Aubert hour meter, and a rheostat. This last is to compensate during the first part of the discharge for the excess in the voltage of the battery over that necessary for the lamps. Each compartment is lighted by a lantern containing two incandescence lamps of 10 candles at 20 volts. One lamp only is lighted for the ordinary service; the other is kept in reserve, and is lighted automatically if any accident happens to the first. The total weight of the four movable cases enclosing the battery of the 12 accumulators is 228 kg. The energy that this battery is capable of furnishing is 5,600 watt-hours. The duration of the lighting is 36 hours with lamps requiring 38 watts.

Whither does this Tend?—We hear that the Southampton Gasworks Company are negotiating for the purchase of the local electric works. The advantages to the former of such an arrangement are manifest, but to those who have the welfare of the industry at heart, the news comes with some misgiving. Suppose the Gas Company obtain control of the supply of electricity, in what light will they regard their acquisition? Southampton is a rising port, and is on the road to become a most important business centre. The credit of the introduction of electricity into the district is generally accorded to Mr. G. J. W. Aldridge, who is well known in electrical circles, and who has pioneered private plant lighting for the baths, library, waterworks, &c. The present position of the electric light company is not a particularly brilliant one, but we should like to feel assured that it will in the future be extended and improved so as to progress with the general welfare of the town. If the Gas Company consider that by annexing their brilliant, but not very powerful rival, they secure another string to their bow, and hope to make a legitimate profit by pushing both branches of their business, no one can take objection to such a laudable desire on their part. If, as seems more probable, they regard the supply of electricity as a dangerous rivalry with their own line of business, and hope by the projected step to squash competition, it is only to be hoped that such proceedings may be avoided by failure to obtain the opportunity. With sufficient capital to enable a pushing and competent man to carry out the necessary improvements, Southampton should possess an electric lighting system commensurate with the growing importance of the town.

"The Provincial Press in London."—A small volume is to be published with this title some time during June. The publishers state that it is not their intention to make the book in any sense a directory of all provincial newspapers, but rather a list of, and some useful details regarding, those having offices or agencies in London, of which there are a very considerable number. We understand that this is the first work of its kind, and it is said to be sorely needed. The address of the publisher is W. H. Wellsman, 100, Fleet Street, E.C.

American Prizes for Science.—A donation was made in October, 1891, to the Smithsonian Institute by Thomas George Hodgkins, Esq., to be devoted "to the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man." The Smithsonian Institution now offers certain prizes, in accordance with the donor's scheme, ranging from $10,000 to $1,000, for the most satisfactory treatise or essay on the subject of air. The treatises may be written in English, French, German, or Italian, and are to be sent in at definite dates during 1894. Further particulars are given in the *Scientific American* for April 22nd. Applications should be addressed to S. P. Langley, Esq., Secretary of the Smithsonian Institute, Washington.

A New (?) Insulator.—*Iron*, a contemporary whose sphere is chiefly metallurgical, has recently described "a new insulator" in a leaderette. It was a surprise to find that the subject of the notice was slate. It appears that some Spanish slate mines have recently found an opening in supplying this material to manufacturers of electrical appliances. Certainly, the use of slate in this way, cannot be regarded as a novelty, although if a new source were discovered from which slate of a marbly nature could be obtained, it would be hailed as a boon by electrical engineers. The novelty, however, does not appear to be specified beyond the statement that it is hoped in many cases slate may supplant ebonite, porcelain and glass. Slate has been tried in the past for use where these materials are now employed, and has been found wanting. Unless the *newness* consists of a special quality of this material which is free from the defects commonly found in its use, we fear the sanguine hopes of our contemporary.

Professor Lunge on the Prospects of Electrolytic Chlorine and Salt.—Our American contemporary, the *Engineering and Mining Journal*, has just published a large volume of 628 pages as a statistical supplement on the mineral industry, its technology and trade, to the end of 1892, which, for the chemist and metallurgist, is the most interesting and complete record of the mineral industries of the world. The contributors to this statistical supplement of the *Engineering and Mining Journal* are all competent men, and many of them are men of high standing. We extract, from the chapter by Prof. Dr. George Lunge on the Progress of Chemical Industry in Europe in 1892, the following prediction as to the future of chlorine and caustic soda by electrolysis:—"Supposing that the Leblanc people are not to be killed by the blow, threatening from that side (Solway Company, and Messrs. Brunner, Mond & Co.), their doom is evidently sealed in another direction. After a long series of failures, some of the processes for making chlorine by electricity now seem to be securely established. We shall not discuss the question which of them may be the best in the field; but it is certain that in some quarters all difficulties have been finally overcome, and that all other old or new chlorine processes will soon be out of favour. We poor Europeans may well tremble as we think of the enormous advantages for all applications of electricity enjoyed by the United States, with their unbounded water-power, coal fields and oil wells, not to speak of natural gas. In all human probability they will soon cease to be importers, and may even become exporters, of bleaching powder. The electrical processes are certainly far greater sources of chlorine than of alkali. They produce from common salt, for every ton of bleaching powder, only half a ton of soda ash, or one-third of a ton of caustic soda." This declaration of Prof. Lunge is certainly of great value; but how does the illustrious chemist make his calculations that electrolysis is a greater source of chlorine than of alkali?

Correspondence.—Owing to the crowded condition of our columns this week, and late arrival of correspondence, we are reluctantly compelled to keep over several letters on subjects of interest.

The Copper Voltameter.—A contemporary has just published a short article on Dr. Oettel's important work on the conditions affecting the accuracy of the copper voltameter. It is well known that it is only with great care and precaution that very good results are obtainable from this apparatus, and the reason has been traced to the formation of hydrogen peroxide and persulphuric acid in the electrolysis, with the effect of producing complication by secondary reactions. The addition of alcohol to reduce these substances enables an acid bath to be used instead of an alkaline one, and hence gives the advantage of much lower resistance, a much larger range of current density, and greater accuracy.

Safety Fuses v. Magnetic Cut-Outs.—Mr. W. E. Harrington has recently published his experience in the use of magnetic cut-outs, as opposed to so-called "safety" fuses, in electric railway work. Granting the utility and need of fuse cut-outs in cases where steady loads are the conditions, and in circuits where the size of the fuse is but a small percentage of the size of the main fuse, he has learned by experience to reject them as protectors of the actual generators in power stations. They do not act with sufficient rapidity, so that damage is done before the fuse melts; in the case of short circuits this is specially serious. For instance, a fuse which is supposed to blow at 50 ampères, will, on short circuit, allow from 100 to 500 ampères to momentarily pass. A magnetic cut-out, on the other hand, will practically open the circuit when the current through that circuit reaches the strength to which the cut-out is set.

The New Canalisations of the Popp Company, Paris.—The Popp Company is still making fresh changes. The electric canalisation itself, which has already undergone three or four changes, is about to be altered again. The insulated cables laid directly in cast-iron pipes only lasted a few days. The insulated cables placed in cast-iron channels filled with bituminous compound, caught fire in several places. Lastly it seemed as if the canalisation in troughs of paraffined wood and in cast-iron channels would prove satisfactory. But now another change is proposed. The cables are going to be taken cased in lead, armoured, and placed directly in the ground in a layer of sand. The cables will consist of a core of copper wires, a double insulating envelope of vulcanised India-rubber, and ribbon coated with India-rubber, a leaden sheath ·0025 of a metre in thickness, a layer of jute, a sheathing consisting of two steel bands, each 1·6 millimetre thick, and an envelope of jute with a special coating. Previous to joints and connections the insulation resistance of this system is to be 2,000 megohms per kilometre at 3,000 volts. Preparations for the establishment of these fresh canalisations have already been commenced in Paris in the Faubourg Montmartre quarter.

Rangoon Electric Lighting.—Mr. J. Stirrat, the municipal engineer, has submitted a report on behalf of the Manchester Edison & Swan Electric Light Company, proposing to light the town on the following conditions:—That they obtain the concession for lighting the town by electricity for 50 years. They undertake to light the same number of lamps as now used, viz., 1,030, and guarantee to produce three times the power of the present oil lamps, or equivalent to 24 candle-power each. That they will provide this improved lighting at the same cost as is now expended in lighting, viz., Rs. 11,000 for establishment, and Rs. 27,000 for stores, maintenance, and repairs, and instead of paying any rent, the company will pay the Municipality 5 per cent. of the net profits earned. Simultaneously with this proposal Messrs. Octavius Steel & Co., of Calcutta, have also tendered to light the town with electricity, and are willing to supply the necessary dynamos, lamps, cables, and fix the same free of charge, provided the Municipality will find the site, engine-power, fuel, oil, and fireman—all skilled labour being supplied by the firm. It has, however, been decided, according to *Indian Engineering* to allot a sum of Rs. 5,000 for a trial installation, after which definite plans and specifications will be drawn up, and tenders advertised in the open market.

City and Guilds of London Institute.—The Council of the City and Guilds of London Institute have elected Mr. H. A. Humphrey a Fellow of the Institute. This distinction is conferred upon those who, having matriculated and successfully completed the course of instruction prescribed for regular students at the Central Institution, and obtained the diploma of Associate, shall have spent not less than 5 years in the practice of their profession, and shall produce evidence of having done some original and valuable research work, or of having otherwise contributed to the advancement of the industry in which they are engaged. Mr. Humphrey obtained the diploma of Associate in 1887, and is now engineering manager of the refined bicarbonate and crystal plant departments of Messrs. Brunner, Mond and Co.

Electric Lighting in the City and Southwark.—The City of London Electric Lighting Company, who have now, by amalgamation, acquired all rights for the electric lighting of the City and Southwark, have decided to apply to Parliament for leave to deposit a Bill this session to amend the Provisional Order Acts granted to the original companies in 1890 and 1891 for the electric lighting of the City, including the district of St. Saviour's, Southwark. The proposed Bill, for which special leave will have to be obtained before it can be deposited, will contain seven clauses, the object of which is to so amend the Acts under which the original companies were incorporated, as to secure "a reduction in the price" of the electric light, which reduction, the preamble states, "will be indefinitely postponed" if the accounts are continued to be kept in the manner prescribed by Parliament in the Acts now sought to be amended.

How to Convert Incandescent Lamps into Geissler Tubes.—We reproduce the following letter from the *Scientific American*, written by E. M. La Boiteaux:—"The idea of utilising burned-out incandescent lamps for performing Geissler tube experiments may be new to many of the readers of your valuable paper, and if so would be pleased to submit it. The experiment may be performed as follows: Procure a burned-out lamp, if possible one in which a piece of the filament has been broken off, leaving the ends separated about an inch. Solder a piece of wire to each terminal of the lamp, and connect to the secondary terminals of an induction coil yielding about a $\frac{1}{8}$th inch spark. Start the coil in action, and holding the globe in one hand, begin to file off the glass point where the lamp has been sealed. This operation must be performed very cautiously, using a fine file with a gentle pressure. The filing should be continued until the discharge diffuses the bulb, and then the point is quickly sealed in the flame. It is, of course, apparent that the object in filing the point is to allow a certain amount of air to enter the globe, producing a low vacuum, through which the discharge will readily pass. The writer has obtained quite a number of beautiful and varied luminous effects in this manner by using the lamps of different manufacture and with very little trouble."

Which is the Armature?—An eminent Austrian firm of electrical engineers were very rightly offended, says *Industries*, when an English electrician said he could not tell which element of their dynamo was the armature and which the field. The multiple current motor has had to put up with a series of insults of this nature. In the discussion on Mr. Snell's paper, read before the Institution of Electrical Engineers, on alternate current motors, the audience were reminded of the expedition against the *Snark*, according to which classical epic the "bowsprit got mixed with the rudder sometimes." We ourselves have always been clear as to which is the armature and which the field, but our nomenclature has not been generally followed. We take it that in an alternating generator the element whose induction is constant is the field, and the part with the alternating current is the armature, and that the same relation holds good if the machine is run as a motor. According to the usual nomenclature, if two machines are coupled together as generator and motor, and if the load is altered so that we have motor and generator, a sort of "general post" is necessary, so that what were at first field magnets become armatures, and what were armatures are suddenly changed to field magnets.

Bedford Electric Lighting.—A deputation of ratepayers have presented a memorial to the Council asking that the electric lighting provisional order may be retained by the Council instead of being handed over to a company.

Madras Electric Tramways Company.—At a special meeting of the Madras Municipal Corporation held on April 5th, an application from the above company, requesting an extension of six months of the concession granted by the Government about this time last year, was taken into consideration. It was resolved that the period asked for be recommended for the favourable consideration of Government (with whom rested the final settlement of the question), provided that the solicitors of the Municipality are satisfied that capital to the extent of Rs. 75,000 has been subscribed.

Chicago Exhibition.—We have received a copy of the official catalogue of the British Section of the Chicago Exhibition. The following are the names of British exhibitors:—General Electric Company; James Lorrain; Epstein Electric Accumulator Company; C. A. Parsons & Co.; Robert Ewing; London and North-Western Railway Company; Collinson and Lock; Ash, Gill & Co.; London Metallurgical Company, Limited; Joseph Higham; G. L. Anders and Kottgen; British Government Postal Telegraph Department; Phonopore Company, Limited; Homacoustic Speaking Tube Company; Ash and Sons; Van der Weyde.

Portable Measurer of Magnetic Field Strengths.—An instrument has recently been designed by Messrs. Edgar and Stansfield for measuring the strengths of magnetic fields by means of a portable coil. The instrument is described as an inversion of a D'Arsonval galvanometer, the torque necessary to maintain a suspended coil conveying a constant current parallel to the direction of the field giving a measure of the field strength. It is sufficiently sensitive to determine the amount of magnetisation of watches which have been too near the poles, and it is said to be of great service in mapping out stray fields and armature reactions. The constant current is furnished by a Hellesen's dry cell, which is found to be very constant. For further details, see *Proceedings* of Physical Society.

Choking Coils.—At a recent meeting of the Physical Society, Prof. Perry read a paper on "Choking Coils." Regarding a choking coil as a transformer with one primary and many secondaries, represented by the conducting masses, he pointed out that all the secondaries could be replaced by a hypothetical single coil, short-circuited upon itself. With his characteristic methods of calculation, he gave an analytical expression for the relation between the exciting current and the magnetisation, &c. By putting the hysteresis factor = 0 in his equation, he finds that observed results agree very well with the calculated values of the current. Hence he is inclined to believe that there is no hysteresis in transformers. Dr. Sumpner followed with a graphic construction, whereby the fundamental equations could be readily integrated.

A New Insulating Material.—A new insulating material, bearing the name of "Stabilit," has been tested by the Electrical Company, Limited, and the results having proved satisfactory, it is now being brought into commerce. This material, which has for some time past been used in the insulation of armatures and magnet and transformer coils, is made in plates, bars, and tubes, or in any desired form, in red or grey-black colour. It can be turned, bored and polished, more easily than India-rubber or vulcanised fibre. It is free from acidiferous or corroding substances, and does, therefore, not attack metal, and is consequently considered better than any material for the insulation of commutators, magnet coils, switches, &c. After four weeks' exposure to a damp atmosphere, stabilit showed no alteration in weight or in its insulation resistance, and after being boiled for twelve hours no increase in weight was noticed. Stabilit, the specific weight of which is 1·6, is not attacked by muriatic acid or dilute sulphuric acid, and is therefore suitable for accumulator cells and battery jars, as experiments have shown. In the course of tests made to determine the usefulness of stabilit for high tension insulation, plates of 0·7 mm. in thickness were not pierced or broken at 5,000 volts.

Watford Electric Lighting.—An electric lighting provisional order is to be applied for by the Local Board.

Electric Lighting at Powderhall Destructor Works.—An estimate amounting to £350 for an electric light installation at the Powderhall Destructor Works, has been accepted by the Edinburgh Town Council.

A New Journal.—The *Phonogram* is the title of a small penny monthly journal, the first number of which has just been published. The advocacy of the phonograph, and the extension of the application of that instrument, seem to be its chief *raison d'être*. It is composed of very light and interesting reading. In the present number, Mr. Wm. Lynd contributes the first portion of an article, "On Tour with the Phonograph," in which he describes some very amusing characters that he has met among his various audiences. The paper is published by the Phonogram Company, Limited, 69, Fore Street, E.C.

A New Resistance Wire.—A Connecticut manufacturing firm has recently brought forward what is said to be a new material suitable for use as resistance wire, or, when rolled into sheets, adapted for heavy resistances. Those who are acquainted with the material in the United States regard the invention as an important contribution in this line of electrical engineering. The wire resembles ordinary copper in external appearance, while it shows a whitish-pink tinge on fracture, and is said to possess great ductility and strength. The torsion test shows over 80 twists in 6 inches for annealed wire, with a tensile strength of 70,000 lbs. per square inch. The specific resistance has been found to be 35 times that of copper, with a temperature coefficient of one-tenth the average of commercial German silver.

Scarborough Electric Lighting.—The Scarborough Electric Supply Company, Limited, have notified to intending consumers of electric energy for lighting purposes that the following rate of charges has been provisionally fixed:—The company's standard charge for electrical energy will be 7d. per Board of Trade unit. In addition, the charge for meter rent will be 2s. per quarter for any number not exceeding 50 8-C.P. 35-watt lamps connected, and 6d. additional per quarter for every 25 such lamps connected. A cash discount of 5 per cent. will be allowed on all quarterly accounts if paid within 14 days. Customers will further be entitled to a rebate (to be deducted from the last quarterly payment in each year) based upon the total number of 8-candle-power 35-watt lamps (or their equivalent) that they have fixed and the average number of hours per annum that the lamps are burnt, calculated according to a table which the company have had printed on the circular distributed.

Electric Traction (Protective Clauses).—The following is taken from the minutes of proceedings of the London County Council, May 16th, 1893:—We understand that a Joint Committee of both Houses is to be appointed to consider the subject of electric traction. There have been several discussions before the Board of Trade and Committees of Parliament as to whether any, and if so, what form of protection should be given to the Telephone Company in the case of Bills authorising use of electricity either for lighting purposes or for motive power. It appears to be admitted that telephone wires constructed and worked on the principle commonly followed by the National Telephone Company are liable to be interfered with by induction, as a result of the use of electricity for other purposes in the neighbourhood. The Telephone Company claim in such cases a clause which, while reserving their position, would place those using electricity for other purposes under considerable obligations in order to provide against possible induction. The decisions of the Board of Trade and of the Committees have varied, and the appointment of a Select Committee to consider the whole question has become necessary, and as the Council is interested in the matter in regard to electric lighting, and, possibly, may be hereafter in regard to tramways which it may be desired to work by electricity, we recommend: That the Council do give instructions that it be represented before Joint Committee. Resolved: That the recommendation of the Committee be adopted.

Accidental Death of a Telephone Linesman.—Thomas White, a linesman in the employ of the National Telephone Company, while clearing some lines which had fouled on the top of a newly-erected building, No. 24, Mitre Street, Aldgate, met with his death through a fall of 43 feet.

Noblesse Oblige.—We cull the following from a recent issue of *Lightning*:—"A Peer well known in electrical circles called the other day at Harness's place, and asked an assistant how he would describe the electricity in the belt in microfarads. 'Well, sir,' was the reply, 'I cannot give you the exact number, but you may take it as being *many thousands*.'"

"Electricity in Mining."—A paper was read before the Electric Club of New South Wales on Friday, April 7th, 1893, on "Electricity as Applied to Mining," by Mr. O. W. Brain (member). The following were the different headings dealt with:—Blasting, Signalling, &c., Water-power and other systems, Pumping, Hoisting and Hauling, Locomotives, Coal-cutting, Drilling, Ventilating, Lighting, Fire-damp; the question in its special application to Australia.

Electric Lighting of Bridges.—In response to an application made by the City of London Electric Lighting Company to the City Corporation in July of last year, they decided on the 17th inst. "that it is not desirable to light the bridges by electricity." As the County Council is promoting a Bill to light the remaining City bridges by electricity, we shall probably be favoured once more with the accustomed spectacle of the City Corporation bringing up the rear in the march of progress.

Electro-Magnetic Theory of Colour Dispersion.—In a recent paper by H. von Helmholtz, attention is called to the fact that hitherto no explanation, that can be considered at all satisfactory, has been given of the phenomena of colour dispersion by means of the electro-magnetic theory. He then proceeds to submit these phenomena to mathematical analysis. Helmholtz's own theories of electrically-charged molecules are combined with the general equations of Clerk Maxwell; and Fresnel's and Cauchy's formulæ are deduced from the electro-magnetic theory of light by means of an application of the principle of least action to electro-dynamics. An explanation of colour dispersion is thus obtained from a new standpoint, and it appears to be quite satisfactory. The paper in which this analysis is set out may be consulted in *Wiedemann's Annalen der Physik und Chemie*, 1893, pages 389—405.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Chamberlain and Hookham, Limited.—The annual return of this company was filed on the 26th ult., and shows that out of a nominal capital of £100,000, in 5,000 "A" and 5,000 "B" shares of £10 each, 1,000 "A" and all the "B" shares have been taken up. The latter class has been issued as fully paid. A call of £3 10s. per share has been made upon the "A" shares, and the full amounts have been remitted.

J. E. H. Andrew & Co., Limited.—The annual return of this company, made up to the 13th of last month, shows that out of a nominal capital of £40,000 in £20 shares, 1,465 shares have been taken up, 300 of which have been issued as fully paid. A call of £20 per share (the full amount) has been made, resulting in the payment of £24,000. This includes a sum of £700 paid on 35 forfeited shares.

Dominion Electrical Company, Limited.—The statutory return of this company has lately been filed at Somerset House, and reveals the fact that out of a nominal capital of £25,125, in 500 ordinary shares of £5 each and 500 founders' shares of 5s. each, 1,000 ordinary and the whole of the founders' shares have been taken up. The full amounts have been paid upon the founders', and £1 5s. has been called on each of the ordinary shares. A sum of £1,750 has been paid on this account.

City of London Electric Lighting Company, Limited.—The annual return of this concern was filed during the past month, and shows that out of a capital of £800,000 in 40,000 preference and 40,000 ordinary £10 shares, 20,000 preference and the whole amount of the ordinary shares have been taken up. On the latter class the full sums have been called, and on the former a call of £8 per share has been made. The total sum of calls received is £560,000.

Anglo-Portuguese Telegraph Company, Limited.—The annual return of this company was filed a short time ago, and shows that out of a capital of £75,000 in £1 shares, 50,000 shares have been taken up, all of which have been issued as fully paid.

CONTRACTS OPEN.

Clonmel—Extension of Time.—The time allowed for sending in tenders for the public electric lighting has been extended from May 25th to June 25th.

Hampstead.—June 8th. For the construction, supply, and laying down of the necessary plant and mains for the supply of electric light in the parish of St. John, Hampstead, for the Vestry. Specifications, plans, and form of tender can be obtained from Mr. A. H. Preece, 39, Victoria Street, Westminster.

BUSINESS NOTICES, &c.

J. A. Berly's Universal Electrical Directory for 1893 (12th year), is now ready, 784 pp. This standard work contains a larger amount of trade information than any other similar publication, and should be in the hands of every engineer or electrician. Free within the Postal Union for 4s.

The Southampton Cranes.—We understand that there will be a formal official starting of the electric cranes erected on the Southampton Town Quay for the Harbour Board by Messrs. J. G. Statter & Co. on the 29th inst., to which representative engineers and officials will be invited. This marks a new era in the development of electric power in this country, and should be welcomed as such by the seaport electricity supply companies. Some time ago the authorities at Southampton had to consider the most suitable and available power requisite to enable them to cope with the increasing trade of the port. The choice of the Town Authorities fell upon electricity as very convenient for the purpose required, and economical as to first cost. It must be noted that the Electricity Supply Company's mains are within a very short distance, and the present requirements at the quay are not of such a character as would warrant a large expenditure on their part for hydraulic pumping stations and mains. The town, it will be remembered, is supplied on the three-wire system, but separate mains are employed for the crane supply, which is quite independent of the lighting plant. At present there is but one crane finished, but preparations are made for the erection of a second. The new dock extension, which is in the hands of the South Western Railway have adopted the well-tried and reliable system of hydraulic cranes, and the name of Lord Armstrong in connection therewith is sufficient guarantee of the excellence of the work there, and electricity will score a decided success should it show its superiority over its well proved rival.

Trips to Chicago.—The first of the Polytechnic trips for the World's Fair, at Chicago, arrived in New York on Friday afternoon last. These trips will be continued every week up to August 5th. The parties travel by the Guion line from Liverpool every fortnight, and from Southampton every Friday and Saturday by the Inman and Hamburg-American lines. A few vacancies still remain. Full detailed prospectus can be obtained on application to the Secretary, the Polytechnic, 309, Regent Street, London, W.

Dresden Electric Lighting.—In our last issue we published an article regarding the electric light system adopted for the central railway station at Dresden. We are now informed that no less than 846 alternating current arc lamps will be used for that installation. From the numerous types submitted, the "Helios" arc lamp has been adopted, and the contract given to the Helios Company, Limited, of Cologne, whose sole agents in this country are the International Electric Company.

Gas Power for Electric Lighting.—For lighting the new station at Leicester the Midland Railway Company have ordered a set of the Dowson gas plant, to work with ordinary gas coke, for about 200 brake H.P. The engines will be of Messrs. Crossley's make.

Catalogues, Lists, &c.—Messrs. Rosling & Matthews, of Bradford, have brought out a new price list of dynamos, motors, electric mining and haulage machinery, accumulators, &c., &c. Some interesting details on "Electricity *versus* Gas," including a table showing the comparative costs of the two illuminants for an installation of 300 16-C.P. lamps, are given, also some remarks on gas engines. A list of the users of dynamos made by the firm, also a number of testimonials are published at the end of the catalogue.

A new illustrated catalogue has been published by Messrs. G. E. Belliss & Co., of Birmingham, dealing with direct-acting electric light engines, pumping engines, launch and boat machinery, boilers, and other machinery. In this book additions have been made, as will be observed upon perusal of page 33, where we notice that the firm have now taken up the manufacture of electrical fans, also of gas compressors, as described on page 176. Messrs. Belliss, we understand, are very busily engaged at present upon electric light engines, of which they show in the present catalogue additional types, including those supplied for Cunarders, and are more especially busy upon Belliss patent noiseless engines. Messrs. Belliss are also engaged upon marine work, having secured the Admiralty contract for the whole of the pinnace machinery they have just given out, viz., 16 sets of engines, boilers, &c. The catalogue on the whole is a very good one, the illustrations being very clear and the whole of the printing very clean. We have pleasure in recommending the catalogue to our readers' attention.

Railway Station Electric Lighting.—In our last issue under this heading we intimated, on the authority of a northern daily, that the electric lighting at the Caledonian Railway Station, Edinburgh, had been installed by the Brush Electrical Engineering Company. We are informed that this is not quite correct, as the plant was laid down by the Glasgow Telegraph Department of the Caledonian Railway Company. The work is only partially in operation yet, as the new station offices are not quite completed. The goods offices, goods shed, shunting yard, &c., are all to be electrically lighted; indeed, gas lighting is to be superseded everywhere within the station district; but the work being extensive it will take some little time yet to finish it. We understand that the arc lighting machines are of the Brush Company's manufacture, but the machines for incandescent lighting were built by Messrs. Holmes & Co., of Newcastle.

Brighton Electric Lighting.—The Lighting Committee of the Brighton Town Council have recommended the acceptance of the tender of Messrs. Goolden & Co., London (for £800), for the supply and erection at the Corporation Electricity Works, North Road, of a switchboard and apparatus. Ten tenders were sent in, the highest being from a Birmingham firm for £3,459. Messrs. Goolden & Co.'s was the lowest tender. Looking at the highest and lowest tender some misunderstanding as to the nature of the work required must have surely arisen.

Private Electric Lighting.—The installation of the electric light at Newbold Revel, Rugby, for Mr. A. H. E. Wood, is now in operation. Mr. A. A. C. Swinton designed and carried out the work.

Mr. Henry Councell has recently fitted up his residence in Marlboro' Street, Farringdon, with an electric light installation.

Falkirk Electric Lighting.—Blairlodge Avenue and gateway leading from the public road has been lighted by electricity, the work being carried out by Messrs. Thomas Laurie & Co., of Falkirk.

Alternating Current Sewing Machines. — Messrs. Shippey Brothers are placing on the market a new type of motor for sewing machines called the "Meston," which is apparently specially designed for working on alternate current circuits.

Electric Light in Glasgow.—The premises of the British Linen Bank, Queen Street, Glasgow, have been lighted by electricity, by Messrs. Anderson & Munro, of Bothwell Street. There are 230 incandescent lights.

Electric Lighting of Holloway Railway Station.—The Great Northern Railway Company have accepted the tender of Messrs. Johnson & Phillips for the supply of "Brockie-Pell" arc lamps and accessories for their Holloway electric light station.

Change of Name.—The Electricity Supply Corporation, Limited, announce that they have changed their name to the Charing Cross and Strand Electricity Supply Corporation, Limited.

CITY NOTES.

The Telephone Company of Ireland, Limited.

THE report of the directors to be presented at the 14th ordinary general meeting, to be held at the offices of the company, Commercial Buildings, Dublin, on May 27th, reads as follows:—

"The directors present their report and statement of accounts for the year ended December 31st, 1892. The development of the business of the company continued during the year, there being at the close of the year an increase of 63 subscribers as compared with the corresponding period of the preceding year, while the accounts show a balance to credit of the net revenue account sufficient to pay the arrears of dividend upon preference shares, and a small dividend on the ordinary shares. Having regard, however, to the absolute necessity for the continuance of a large expenditure on capital account, the directors are unable to recommend that any portion of the earnings should be distributed among the shareholders. Besides the outlay of capital requisite in order to meet the development of the business which may be expected on the completion of the Post Office trunk service, the progress made in telephony necessitates the renewal of the entire of the internal arrangements of the company's exchanges in Dublin, Cork, Limerick, Dundalk, and Drogheda, and the replacement of the present switchboards by others of the latest construction, while on the outdoor works a large capital expenditure is also absolutely required, hence the balance to credit of the revenue account, and for some time the future profits of the company should, if the company continued its operations and unless the shareholders provided the further necessary funds, be expended on capital account. In view of this fact, and of the fact that the preference shares offered in January, 1890, or even the debentures offered in July, 1890, were not taken up by the shareholders, and that the directors were obliged in order to obtain a subscription for the debentures, to incur the large expense stated in the accounts for the year 1891, the directors, while the working of the company shows such favourable results, were forced to the opinion that an amalgamation with the National Telephone Company, on fair terms, would be most to the advantage of the shareholders in this company. Accordingly, after somewhat protracted negotiations, an agreement for amalgamation has been entered into between this company and the National Company, subject to the sanction of the shareholders of this company. By this agreement the National Company agrees to pay, as of December 31st last, the sum of £81,300 for the entire assets of this company. The National Company waives any claim to participate in the assets of this company in respect of the moiety of the ordinary share capital to which they are entitled. These terms the directors consider fair, and, under the circumstances, advantageous to the shareholders of this company. After paying off the debentures (£15,000) and the preference share capital (£46,197), there would remain for division among the ordinary shareholders the sum of £20,103. This, however, would be subject to the claims of the preference shareholders for arrears of preference dividend to December 31st last, and to the necessary expenses of liquidating this company. A very large proportion of the holders of the preference shares have assented to the amalgamation with the National Company, conditional upon their receiving 20s. per share in full discharge of principal and arrears of dividend. Under the agreement with the National Company, the interest upon the debentures and the dividend upon the preference shares accruing since January 1st last, up to the date of the completion of the agreement, are to be paid by that company. This agreement will be submitted to the general meeting, which has been convened, and the directors recommend it to the approval of the shareholders. The agreement may be inspected previous to the meeting at the office of the company. One of the directors, Alderman V. B. Dillon, jun., retires at this meeting, in conformity with the articles of association, but is eligible for re-election. The auditor, Mr. John M. Kean, also retires, but is eligible for re-election."

Reuter's Telegram Company.

THE directors' report for the year ending December 31st last shows that the net profits, after payment of current expenses, and deducting rebate on unexpired subscriptions, amount to £3,567, including £99 brought forward from the last account. In accordance with the articles of association, which authorise the appropriation of the reserve for the purpose of equalising dividends, the directors have transferred the sum of £1,500 from that fund to the profit and loss account, making the total amount available for distribution £5,067. The usual interim dividend of 2½ per cent. was paid in October last, and the directors now declare a further dividend of 4s. per share, making a total distribution, free of income-tax, of 5 per cent. for the year. This will absorb £4,814, and leave a balance of £253 to be carried forward. A resolution will be submitted to the meeting authorising the directors to augment the annual grant made to the officers' life insurance and superannuation fund, established in 1881, in order that effect may be given to the portion of the scheme dealing with superannuation.

Stock Exchange Settlements.—The Stock Exchange Committee have appointed special settling days as under:—Tuesday, May 30th: Charing Cross and Strand Electricity Supply Corporation, Limited—20,510 shares, Nos. 1 to 6, 215 to 718, and 10,001 to 30,000. Pacific and European Telegraph Company, Limited—£100,000 4 per cent. Guaranteed Debentures, Nos. 1 to 1,000. And ordered the undermentioned securities to be quoted in the Official List:—Charing Cross and Strand Electricity Supply Corporation, Limited—20,510 shares, Nos. 1 to 6, 215 to 718, and 10,001 to 30,000. Pacific and European Telegraph Company, Limited—£100,000 4 per cent. Guaranteed Debentures, Nos. 1 to 1,000.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending May 21st, 1893, amounted to £794; week ending May 22nd, 1892, £766; increase £28; total receipts for half-year, 1893, £17,735; corresponding period, 1892, £16,874; increase £1,861.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 19th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,680.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, May 18th.	Closing Quotation May 25th.	Business done during week ended May 25th, 1893. Highest.	Lowest.
195,100£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 — 104	101 —104	...	...
1,247,720£	Anglo-American Telegraph, Limited	Stock	50½ - 51¼	50½ - 51½	51½	50½
2,876,140£	Do. do. 6 p. c. Preferred	Stock	91½ - 92¼	91½ - 92½	93	92⅜
2,876,140£	Do. do. Deferred	Stock	11½ - 12	11½ - 11⅝	12	11⅝
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜ - 12¼	11⅜ - 12¼	12 1/16	12
36,400£	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3½	3⅛ — 3⅜	3½	3 1/16
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ - 2⅜	2⅛ - 2⅜	2 5/16	...
125,000£	Do. do. 4½ per cent. Debenture Stock	Stock	108 —110	108 —110	109½	108½
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	2 — 3	...	...
630,000£	City and South London Railway	Stock	37 — 39	37 — 39	37½	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	12 — 12½	12 — 12½	...	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12 — 13	12½ — 13	12½	...
$7,716,000	Commercial Cable, Capital Stock	$100	140 — 150	140 —150	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	3/16 — 5/16	3/16 — 5/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½ - 5⅝	5½ - 5⅝	5⅝	...
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	12 3/16	...
6,000	Do. do. 10 p. c. Preference	10	18½ — 19½	18½ — 19½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 12	11½ — 11⅝	11⅞	11⅝
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15⅝ — 15⅝	15½ - 15⅝	15 7/16	15 7/16
70,000	Do. 6 p. c. Preference	10	16½ — 17	16½ - 17	16⅝	...
105,900£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 - 111	109½	108⅝
1,294,100£	Do. 4 p. c. Mortgage Debenture Stock	Stock	113 —116	113 —116	114¼	113
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅝ — 16	15⅝ - 15⅞	15⅞	15⅝
70,600£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
250,200£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	114 —117	114 —117	...	...
108,700£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	...	...
146,800£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
300,000£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	101 —104	...	...
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	2½ — 2⅝	2½ — 2⅝	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1/16 — 3/16	1/16 — 1/8	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	¼ — ½	3/16 - 5/16	5/16	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	0 — ¼	3/16 - 5/16	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	1 — 2	1 — 2	..	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜ — 9⅞	9⅜ - 10	10	9⅜
180,042	Do. do. 6 p. c. Preference	10	15⅜ - 15⅞	15⅜ - 15⅞	15 3/16	15⅜
150,000	Great Northern Tel. Company of Copenhagen	10	19 — 19¼	19¼ — 19⅜	...	...
200,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 -108	105 -108	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ - 5½	4½ - 5½	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6½ - 7½	6½ - 7½	...	..
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	23 — 24	23 - 24	23	...
200,000£	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	103	102½
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ — 3½	2½ — 3½	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4½ — 4⅝	4½ — 4⅝	4⅝	4 1/16
10,000	Do. do. fully paid	5	6½ — 6⅝	6½ — 6⅝	6½	5⅝
38,348	London Platino-Brasilian Telegraph, Limited	10	4 — 6 xd	4 — 6 xd	...	...
100,000£	Do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	..
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6 — 6½	6½ - 6⅝	6½	6 7/16
50,000£	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	103 —106	...	...
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	4⅞ - 5⅛	5 — 5⅛	5⅛	5
15,000	Do. 6 p. c. Cum., 1st Preference	10	15 — 15½	15 — 15½	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	14½ - 14⅝	14½ — 14⅝	14 9/16	14½
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5⅛ — 5⅜	5⅛ — 5⅜	5⅜	5⅜
725,477£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	113 —116	112 —115	113⅜	...
48,800£	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,451	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛ — ¼	⅛ — ¼	...	..
100,000£	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	... ...	101 —104	...	...
11,802	Reuter's Limited	8	7 — 8	7 — 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7½ — 8	7½ — 8	7⅞	7⅝
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	8⅜	...
3,381	Submarine Cables Trust	Cert.	119 —124	119 —124	121	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3 — 3½	3 — 3½	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	30 — 32	30 — 32	31⅜	30
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	104½	103⅜
58,000	United River Plate Telephone, Limited	5	2 — 3	2 — 3	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 —100	...	..
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ - 6½	5½ - 6½	...	...
260,900£	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	...	...
30,000	West Coast of America Telegraph, Limited	10	2 — 3	2 — 3	2⅜	2⅜
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 —106	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7½ — 8 xd	7½ — 8 xd	7⅜	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5⅜ — 6½xd	5⅜ — 6½xd	6½	6½
33,129	Do. do. do. 5 p. c. Deferred	7½	1⅜ — 2⅛	1⅜ — 2⅛	...	...
178,200£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	107 —110	106 —109	...	...
222,700£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 —109	...	..
88,321	West India and Panama Telegraph, Limited	10	1½ — 1⅝	1⅛ - 1⅜	1⅜	1⅛
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11½ — 12	11½ — 12	...	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9½ — 10½	9½ — 10½	...	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	108 —111	108 —111	110	109⅜
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
169,000£	Do. do. 6 p. c. Sterling Bonds	100	101 —104	100 —103	101	...
49,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½ — 5⅝	5½ — 5⅝	5⅝	...

*Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5½—5⅝.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 103 –103.—Electric and General Investment, shares of £5 (£1 paid), 1⅝—2⅛.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5 –5⅛.—House to House Company (£6 paid) 1⅛—2⅛.—Do. 7 per cent. Preference of £5, 5 –5⅛.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅛ –5⅜, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6⅛.—Liverpool Electric Supply Shares of £5 (fully paid), 6⅛—6⅜.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, 6 per cent. £100 Debentures, 101—102. Bank rate of discount, 4 per cent. (May 18th, 1893).

TELEGRAPHIC COMMUNICATION IN THE WEST INDIES.

How Trade and Intercourse may most Successfully be Restricted within the Narrowest Limits.

By Dr. R. B. ANDERSON.

In my previous articles I have given *two* illustrations that I think, though on a small scale, thoroughly justify the title I have selected.

It is true the illustrations apply chiefly to the small and unconsidered island of Tobago, but then how beautifully complete they are for their purpose. They contain every element that such illustrations could have; certainly, all that are necessary to my case.

The conduct of the local government has a painful touch of suspicion of some self-interest lurking in some dark corner; for it is difficult, except by supposing some private end to be gained, to imagine why the offer to lay a cable to Tobago for £3,500, at a total cost of £400 per annum, was sedulously concealed, and the offer to lay and work one at £1,600 per annum for ten years was alone put forward.

Of a monopoly in full possession, it would, as I have said, be too much to expect experiments in the way of large and far-sighted reductions of rates—at the risk of even temporary loss—but, certainly, such an alteration as I have described in the La Guayra, Tobago, Trinidad route, unattended with material expense, and offering a large field for possible business, it is not too much to expect should have been tried; whilst, on the other hand, the duty of the Government to in every way promote the laying of a cable to Tobago, on the several grounds of the interests of Tobago, and of Trinidadians seeking a convenient health resort, and of advantage to the means of Imperial defence, appears clear, and the concealment such as to call for investigation.

I now have to mention another change which I trust may not be opposed, which would tend to encourage passenger traffic at least, and in several ways would operate favourably to promote telegraphic business, and, with a minimum of expense or inconvenience, would practically bring the West Indies to little more than half their present apparent distance from this country.

Under present arrangements, the Royal Mail steamer, outward bound, leaves Southampton on alternate Wednesday afternoons. The last left on the 24th of this month. The first port of call, where the routes to and from other islands converge, is Barbados, and the outward boat arrives there on Monday, June 5th, at six o'clock in the morning. She therefore just misses by 36 hours the homeward bound boat, which leaves Barbados for Southampton on the previous Saturday, June 3rd, at six o'clock in the evening. The next homeward Royal Mail steamer does not leave Barbados until a fortnight later, Saturday, June 17th, and does not arrive at Plymouth until Wednesday night, June 28th, making 36 days from the date, May 24th, when the outward boat left, as the shortest time in which it is possible to receive an answer to a letter, or to hear from any passenger who travelled by her. This is longer by several days than the time required to obtain a reply from, or hear from a traveller to, Bombay, and about as long as the return journey to Ceylon, so that the general impression produced is that the West Indies are as distant as the East.

The apparent proximity of our Eastern possessions is increased by every available means, but especially by the transmission of the mails by rail to Brindisi. But it would appear that every malicious art is called into play to separate us from our daughters of the West.

It is true that by the present arrangement they can, as it were, enjoy the feminine privilege of speaking all at once, or, in other words, that Demerara and Trinidad at 200 or 300 miles further, and Jamaica at 1,000 miles further, enjoy, in replying to letters, equal terms with Barbados, which is that much nearer.

My object is to show that whereas this equality is quite an illusory advantage, all would, in fact, share the very great advantage that would result from such a change of system, as would allow of a prompt return communication with Barbados; and, indeed, to anyone arriving for the first time at Barbados on the Monday morning, and learning that the boat for England had left on Saturday evening, anxious to write by her, or, perhaps, on the grounds of the utmost importance, anxious to return by her, it would be much easier to show why the arrangement should be altered, than it would be to find any satisfactory reason why so ingenious a way of disappointing and inconveniencing him should have been invented.

It is true he could telegraph to his friends in England, but I shall presently show some substantial considerations that might "give him pause," and as yet no means has been found whereby he could himself return on the "copper road of the lightning."

Nothing could be easier than to change the present ill-timed dates of arrival and departure. The outward mail might leave on Tuesday instead of Wednesday, and by a slight increase of speed, could arrive in Barbados on Saturday morning, instead of on Monday morning; or totally different dates might be arranged, the outward boat leaving on the Friday, say, May 26th, and arriving in Barbados on Wednesday, June 7th, meeting the homeward boat leaving the same day, and arriving at Plymouth on Sunday evening, June 18th, a period of only 23 days to receive a reply from Barbados, or to go thither and return, instead of 36, as at present.

Besides the reason I have mentioned, (*a*) that if the outward and homeward vessels met at the first port of call, that port would have the advantage of being within 23 days of England, whereas others would be at 37; the only reasons I have heard advanced against the change I am advocating are, (*b*) that the business of the outward and homeward mails in Barbados would be thrown into one day; (*c*) that to make the day of departure one day earlier would curtail the time available in Europe for replies to West Indian communications, and (*d*) that it would not pay the Royal Mail Steam Packet Company to raise their speed, even in so slight a degree as might be necessary.

It is in my favour that these supposed difficulties are at least not cumulative. The speed would not require to be raised if the dates of departure from England were a day earlier. If the speed were raised the day of departure need not be altered. The crowding of outward and homeward business into the same day would only inconvenience Barbados—and Barbadian energy would soon get over that—whilst the slight delay to the other Islands would not apply to Barbados, but, as well as any inconvenience, would be amply compensated by the shortened period of communication with England.

But when I give some account of present telegraphic conditions, it will be seen that this shortened communication with England will, in a large number of business and other matters, at once be advantageously felt throughout the West Indies, to the very great benefit of the mercantile and planting interests in those Colonies, and of their correspondents in this country, and, as I propose to show, to the material benefit as well of telegraphic interests in that province.

At present it costs 10s. 5d. to send a message between Trinidad and London, 12s. 2d. per word between British Guiana and London, or 9s. 11d. per word between Barbados and London. And I think that, though a trifle less than the others, 9s. 11d. per word is a fairly sufficient reason why the traveller arriving in Barbados would be glad to write rather than to telegraph, and would be fairly content could he communicate with his friends in the space of 23 days from leaving. From New York the present rate is, owing to competition, 1s. per word; from Australia it is 4s. per word; from Bombay it is 4s. per word. Though further than New York, the West Indies are, as I have already shown, very much nearer than Bombay.

The reason given for these heavy rates is the necessity for earning interest on the large capital sunk in the enterprise; and indeed West Indians, and those doing business with the West Indies, are told in express terms that they should be grateful for what has been and is being done for them, since the dividends earned by ordinary shares practically leave the virtue of ordinary shareholders in so investing their money for the good of their fellow men in those regions to be its own reward.

There have been some persons connected with the West Indies unreasonable enough to suggest that if the rates were lowered those colonies would benefit, business be developed, and the company earn better dividends.

To these the stereotyped reply is made to which I alluded in my first article. "The whole business to be done is small, and its scope limited, consisting only of a certain quantity that is absolutely unavoidable, and must be paid for at whatever rate is charged; and it would not be increased, or at all events it would not be increased in proportion if we lowered the rates; for instance, if we lowered them to half, the business would require to be doubled; and it would certainly not be doubled, or nearly doubled." Mr. Earle, the chairman of the board, told me this in almost these words, and added a good deal more of weighty statement and argument to show that lowered rates in the telegraphic world have not by any means always brought a corresponding increase of old or development of new business. And, as I have said, you cannot tell a company that has to bear the brunt and take the risk that they shall make such an experiment contrary to their own conviction; and you cannot take away their property or compel them to lower their tariff.

But if they enjoy advantages from you, as this company does from the West Indian colonies, you certainly have the right to enquire the grounds of their judgment, to satisfy yourself that they are reasonable, that you are not being made the victim either of greed—however unwise—(that goose is killed daily in connection with the West Indies) of folly however sententious; or of other interests than those that you have some obligation to regard. To enable one to arrive at such conclusions, there are often tests available, and circumstances afford West Indians several, which I propose to apply in the present case. I do not think that any man, or body of men, would venture in the light of day, or through the public press, to advocate any measure that would savour so strongly of confiscation as the sudden and groundless discontinuance of advantages that are attended with an implied promise of continuance so long as the equivalent conditions are fulfilled. If not in legal equity, that would, in moral equity, be distinctly dishonest. But then, in moral equity, the spirit, as well as the letter of the conditions, must be fulfilled—and to the party who comes into *that* court, the rules of legal equity that he who seeks equity must do equity—and that he must come into court with clean hands, apply with special force.

The West Indian colonies have ever since the laying of the cables of the West India and Panama Telegraph Company paid that company considerable subsidies, which still subsist to the value in these colonies of £18,900 per annum.

As an equivalent, they have had a cable more or less constantly available, and more or less constantly in working order, and they have had, at such rates as I have given, the means of communicating telegraphically with each other and the outside world.

But, besides this, they stipulated that they should be furnished with a daily bulletin of news of public interest to them, and with the daily prices current and leading quotations. And here, I regret to say, a distinct cause of difference and friction between the colonies and the company arises. The colonies are dissatisfied with the quantity and selection of news supplied, and the company say that to

supply news at all should not be required of them under the subsidies, but that all they transmit should be paid for by the senders. In seeking to enforce this obligation, the colonies are merely insisting on the fulfilment of a definite term of the contract. In seeking its discontinuance, the company are contending for a different and more favourable contract, but place themselves either in the false position of seeking a favour, or in the dangerous position of regarding the contract as terminable by either side at the completion of the periods of the subsidies.

But besides this very definite issue, there are other conditions that, morally, must be admitted to be as binding on the company as the renewal of terminated votes of subsidies is on any colony. Of these, not the least is that the methods and conduct of business of the company should keep reasonable time and step with the progress and improvement of similar undertakings in other parts of the world, arising from the advance of modern science and the more intelligent application of acquired experience under the pressure of healthy competition.

To deny this would be to assert that communities, in conceding favourable conditions for terms of years in order to encourage new undertakings and to secure the benefits of new inventions, enter into an implied contract to remain for ever satisfied with the stage then attained, and never to discard it for any other and newer invention, however superior, or to seek any further advantage, however general elsewhere, which is absurd. And it is clear that it is for the concessionaire seeking a continuance of his concession to show that he has complied with all the conditions in the past, and is willing to observe all moral equities in doing so as to old, or even new, reasonable conditions in the future.

Another condition of concessions is that they should benefit the concessionaire and the concessionary alone, and not be misappropriated for the undue benefit of third parties, not parties to the contract.

A third condition is that a concessionaire is morally under obligation to do the best he can with third parties, in the interest of himself and the concessionary, so that secret profits or advantages unacknowledged would be a breach on his part of the moral equities of his position that would entitle the concessionary to disregard every obligation not *legally* binding upon him.

Subject to these limitations and definitions, there is in the colonies no moral equity to withdraw the subsidy, or to use the legal power of refusing to renew the subsidy on expiry of a term, as a means to secure either more and better equivalents in public work done, or a cheaper tariff for private work. And it would be most unjust and inequitable morally to stipulate before renewing subsidies that the tariff should be reduced to half its present value in face of a well grounded opinion that the business done would not be at least doubled, since that would be to say: Having laid down your money in cables for our advantage, and those cables being of little value to take up again, you shall now lose interest on much of that capital, either by reducing your tariff, or by ceasing to receive our subsidies. *That* would practically be an act of confiscation, and few cables indeed would have been laid or other enterprises undertaken on the expectation that such conduct might be possible.

If on the other hand there is reason to suppose that business would be facilitated and increased in that proportion, it is certain that from that point of view the concessionary would be morally justified in availing himself of his position.

But before this stage is reached, other tests will be applied: "Are you advancing *pari passu* with similar undertakings?" "Are you giving us our fair share of the benefits of a joint undertaking?" and "Have you any concealed advantages which place us at a corresponding disadvantage?"

It clearly rests with the company to show that, like the fishes in the frying pan in the Arabian Nights, they are doing their duty, although, if I remember aright, assertion was in that case allowed as evidence.

On these subjects, of so great interest to the West Indies, to the company, and to me as having West Indian interests, I am in correspondence with them, and have asked for information that may place them in the most favourable light; and that more particularly, because, except that justice is the higher obligation, my interests do not coincide with theirs, so long as theirs are considered as identical with high tariffs and circuitous routes.

With a three weeks' (23 days) return voyage from England to Barbados, I am confident that a new line of business would at once begin to develop.

Instructions and enquiries would be written to agents in Barbados, telegraphically transmitted to other colonies from Barbados, the replies telegraphed to Barbados, and thence transmitted by letter to England.

It is clear that in this way the telegraphic communications on such business would be fuller and more detailed than for long and expensive ocean messages. The subjects that at present compel ocean messages would not cease to do so; but the new business would consist of a less absolutely imperative order, which yet would greatly benefit by the gain of a fortnight in transmission, at the comparatively small cost of local rates. Indeed, to encourage such new business, it would appear to be well worth while for the company to create special and greatly reduced local rates, and thus bring, as it were, the rest of the West Indies to close quarters with Barbados, and equally with her within 23 days of the mother country. I am waiting with interest the view the company will take; and this more particularly, because that view will probably largely depend on whether the company has interests to serve outside of the limits of its own sphere in the West Indies; that is, in plain terms, whether the rates on European messages are kept up for the benefit and in the interest, not only of the West India and Panama Telegraph Company itself, but also in the interest of the lines that transmit messages from Santiago de Cuba to America and Europe.

CABLE SOUNDINGS IN THE PACIFIC.*

COMMANDER TANNER, U.S.N., describes the recent work of the U.S. ships *Albatross* and *Thetis* in surveying possible routes for a cable between San Francisco and the Hawaiian Islands in the last number of the *Transactions* of the Geographical Society of the Pacific. He commenced work in the *Albatross* on October 11th, 1891, off Salinas, in the Bay of Monterey, at the head of a great submarine canon, which carried deep water close to the shore. The axis of this trough was followed until oceanic depths were reached, and a great-circle course was then followed to the island of Oahu, soundings being taken at intervals of 5, 10, and finally 15 miles. The gradual increase of depth continued for 486 miles from Salinas, where it was 2,895 fathoms, then gradually diminished to 2,014 fathoms about 690 miles from the Californian coast. This elevation was steeper on the western side, and in crossing it close soundings were made. For 146 miles farther the line showed depths of 2,400 to 2,700 fathoms. On another trip the ship passed within eight miles of the elevation previously found, without any change of depth. A somewhat remarkable depression with one sounding of 3,186 fathoms was found in 31° 54′ N., 136° 44′ W., which was the deepest water found on the survey. A slight rise followed on, which, at a depth of 2,085 fathoms, particles of sand were detected by the microscope in the ooze which covered the bottom, a circumstance of very rare occurrence. A stretch of 700 miles followed with average depths of 2,900 fathoms; but 210 miles from the east end of Oahu an elevation, with a depth of 1,256 fathoms, was found separated from the land by a depression of over 2,800 fathoms. Several lines of soundings were taken up the relatively steep slope to the coast, all of which showed a gradual rise, forming a good bed for a cable. Waikiki, about three miles from Honolulu, was fixed on as the best landing place for a cable. On December 12th, 1891, the *Albatross* started to sound a rhumb-line to San Francisco, the maximum divergence of which, from the great circle route followed in the outward voyage, was 70 miles. From a depth of 603 fathoms, 20 miles from land, there was a descent of 1,178 fathoms in four miles, a slope of 1 in 3·5, but notwithstanding its steepness, no rocks were indicated. On the whole the character of the depths was similar to that of the outward voyage, the greatest depth met with being 3,038 fathoms. There were several gentle rises, on which the depth was under 2,000 fathoms. Commander Reiter, on the U.S.S. *Thetis*, surveyed a third possible line for the cable in April, 1892, from Point Conception to Hilo, in Hawaii. Similar conditions were found, the most notable rise, named after Reiter, occurring on the great circle course, 405 miles from Point Conception, with only 976 fathoms over it, while the surrounding ocean bed had a normal depth of 2,500 fathoms. The later part of the line showed greater depths and a more rugged sea-bed, with signs of recent volcanic disturbance. The maximum depth of 3,228 fathoms occurred within 230 miles of Hawaii, indicating an extensive trough surrounding the whole island group on the east. The *Albatross* great-circle line was 2,091 miles, the *Thetis* line 2,050 miles in length. No obstacle remains to the laying of a cable save those of an economic kind.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

THE DISTRIBUTION OF POWER BY ALTERNATE-CURRENT MOTORS.

By ALBION T. SNELL, Member. (Read April 13th, 1893.)

MULTIPHASE alternate-current working, although demonstrated at the Frankfort Exhibition, has not yet found favour either in England or America; but on the Continent the Drehstrom has been used with success for several important schemes, and larger applications lie in the near future.

It has been pointed out, with justice, that multiphase alternate currents offer no real advantage in comparison with single-phase ones for merely the transmission, as distinguished from the distribution, of power. It is, perhaps, for distribution proper—*i.e.*, where a number of motors, varying in size, and lying over an extended area, have to be supplied from a common and probably distant source of power—that the multiphase systems find their field of usefulness.

The object of this paper is to discuss the various alternate-current motors now in the market, and, perhaps, to see how far they lend themselves to a system of distribution in which the principal conditions of supply may be stated, as follows:—

Firstly, the pressure in the transmission mains must be as high as possible.

Secondly, the pressure must be maintained fairly constant at the centre of distribution.

Thirdly, the pressure at the motor and lamp terminals must be comparatively low; and

Fourthly, the system must admit of lighting all over the area of distribution by the use of proper converters.

These points are by no means easy to obtain, even singly, and when they must be concurrent, the difficulty is much enhanced.

1.—SINGLE-PHASE SYNCHRONOUS ALTERNATE-CURRENT MOTORS.

Single-phase synchronous alternate-current motors have been used since the memorable experiments at the North Foreland in 1884, but comparatively little progress has been made in their application to general commercial purposes; and the reason for this probably lies in

* Reprinted from the *Geographical Journal*, May, 1893.

the fact that the synchronous system is practically limited to a single pair of machines, for the starting of the motor by auxiliary power is not a prohibitive objection with one large machine, although out of the question with a number. On the other hand, the high efficiency of synchronous motors, and their perfect regulation of speed with varying loads, renders them especially suitable for a variety of purposes; and no efforts have been wanting on the part of scientists and engineers to place a self-starting single-phase motor in the market, but hitherto without success. It will serve no useful end to describe in detail all the various attempts, but the limited conditions may be best gauged by a consideration of the difficulties involved, and by a few typical examples showing the directions in which solutions have been tried.

The following peculiarities are found in alternate-current working with single-phase synchronous generators and motors:—

(*a*) The dynamos are always separately excited.

(*b*) The motors are usually separately excited in order to save the complication of commutators.

(*c*) The motors must be raised approximately to the speed of synchronism before the dynamo circuit can be closed.

(*d*) The torque on any motor must not exceed a certain value or the machine will stop.

(*e*) The current lags behind the pressure by an angle which is a maximum when the motor is running light; and there may be a relatively large idle current, which, though representing little energy at the motor, causes a serious loss in the supply mains and dynamo armature.

(*f*) Motors must be designed not only with reference to the pressure of supply, but also with regard to the frequency of the current, and hence are only suitable for working on particular circuits; and

(*g*) Alternate motors, excited by either a direct or by a single-phase alternating current, have dead points in each period of alternation.

The earliest attempt to meet these conditions was by laminating the field magnets of an ordinary direct-current motor and modifying the winding so as to make the self-induction as small as possible. The results were not successful. With shunt windings it is found to be practically impossible to excite the magnets excepting with large currents and few turns of wire, and even then, owing to the difference of phase between the field and armature currents, the torque is insignificant compared with the current used, and the dead points may involve difficulties. The series winding is better, but still useless for commercial requirements; for though by carefully adjusting the windings it is possible to obtain a smaller lag, the weight output is still very small and the dead points remain.

The loss by hysteresis in each case is so great as to be probably prohibitive even neglecting the other objections. The crux is the frequency. This would, most likely, have to be reduced to something of the order of 20 ~ per second, and such a current would be useless for lighting and would largely increase the difficulty from dead points. Indeed, from this aspect the frequency should be high and the armature heavy enough to act as a fly-wheel. The author has made a number of experiments in this direction and finds that the eye can easily detect 30 ~ per second, and he believes from this cause it would not be expedient to work at less than from 40 to 45 ~.

Another method involves the transformer principle, but is really only applicable to small machines. It originated with Mr. Jacobi, when one of the author's assistants, and a few motors were designed by them conjointly. With this type the armature is wound in the usual way, drum or cylinder, and has a collector of the ordinary type. The field cores are laminated and wound with two windings, one of which is coupled to the supply mains, and the other connected across the armature terminals, thus forming a secondary circuit. Such a motor gives a considerable torque, is self-starting, and has probably an efficiency of 60 per cent. in 1-H.P. machines. It has dead points in each alternation undoubtedly, but they are not very apparent. The chief difficulty is, that owing to the configuration of the iron of both field and armature, and the air gap, the number of lines of force passing through the two circuits is not the same; and, moreover, there is a considerable lag between the primary pressure and current. And also, which is equally important, the primary and secondary currents are not in phase. With small armatures having few turns per coil the sparking is little, the best results being obtained when the axis of the armature field is at 90°, or thereabouts, to that due to the exciting current. The armatures may advantageously be wound with two circuits so as to avoid short-circuiting coils beneath the brushes.

2.—Use of Condensers.

The next step in alternate motor design was the attempt to balance the self-induction of the shunt-wound field magnets by a condenser, placed in series with the windings. If the condenser be correctly chosen for the frequency and the capacity of the circuit, its E.M.F. will theoretically be equal and opposite to the counter E.M.F. of the magnets, and so the exciting current will only have to be driven against the ohmic resistance of the winding, and moreover the pressure and the field current will be in phase. The armature has but small self-induction, and so its current will be also nearly in phase with the field current, and the maximum magnetism in field and armature will occur at approximately the same instant of time. Therefore the energy absorbed by the motor can be very nearly gauged by the product of the number of volts and ampères. In practice, owing to the armature reactions, the condenser will most likely not exactly counteract the counter E.M.F. at all loads. And again, even assuming such machines to be commercially practicable, they would only be suitable for one periodic time. If condensers were applied to series-wound motors, they would be coupled in shunt to the field windings; but the objections above mentioned are equally applicable. A most important point to be noticed in connection with condensers used in this manner, is the relatively high pressure which might occur at the field terminals owing to fluctuations in the current. This difficulty can be obviated by arranging the condenser and windings in sections, but such a plan is open to objection on the score of complication. Messrs. Hutin and Leblanc* have recently patented several modifications of designs involving condensers.

An interesting modification of the shunt-wound single-phase motor has been designed by Messrs. Stanley and Kelly. It is well recognised that the lag of the armature current does not coincide with that of the field current in an ordinary shunt-wound motor supplied with an alternating current, and hence the torque is not proportional to the armature current, but has a maximum for some particular value which must be determined experimentally for each machine. To meet this difficulty these gentlemen place a condenser in series with the shunt coils, and put short-circuited coils in recesses cut in the pole pieces. These coils carry currents induced by, and therefore proportional to, the armature current, but always in such a direction as to tend to decrease the self-induction of the armature coils, and consequently the lag of its current also. The arrangement has the disadvantage of raising the interpolar resistance, and is likely to cause serious distortion in the main field.

It has also been proposed to supply the idle currents prevailing with alternate current working by suitable condensers placed across the supply mains, preferably at the transformers sub-stations.

3.—Split-Current Rotary-Field Motors.

Another attempt has been made in the direction of splitting the main current into two separate branches with phase differences of 90°, and so producing a bi-phase rotary magnetic field, the armature circuit being closed on itself, or through an external resistance, and carrying a current induced by the revolving field. In principle this machine is similar to a Tesla motor supplied with two separate currents, one of them lagging 90°. If a current be divided into two circuits with different coefficients of self-induction, the current in one will lag behind that in the other; and if the one circuit have no self-induction but capacity, and the other have relatively a large self-induction, then the phase difference can be made as near 90° as desired. Such a machine has been designed by Messrs. Hutin and Leblanc, but the author does not know how far it has been successful in practice. The points gained by this arrangement, however, mark a considerable advance in the design of alternate motors for use off ordinary supply mains. The motor is self-starting; non-synchronous; if stopped through overloading, will start again as soon as the excess of load is removed; and is self-exciting. But it appears to be still far from perfect; for, owing to the armature reactions on the field, it is difficult to see how the current, in the circuit containing the condenser, can be self-adjusting for varying loads with a fixed pressure of supply; and consequently the output of such a motor will probably be less than that of a Tesla one with two independent currents. The difficulties attending the condenser are precisely the same as those previously referred to with the synchronous type of motor.

Messrs. Stanley and Kelly have recently devised a quadrature motor, which presents some interesting features. In one of the circuits is placed a solenoid with low ohmic resistance, but large self-induction; and in the other circuit is a series of secondary batteries which have capacity, and, therefore, act as a condenser. The result arrived at is a lag of 45° in the current of the inductive circuit, and a corresponding advance in the capacity branch, the result being a total difference of phase of about 90° between the two currents. The battery does not need to have large storage capacity; and as the number of plates is arranged so as just to prevent electrolysis there will be no "forming." But lead plates used in this manner in diluted sulphuric acid rapidly sulphate, and hence are likely to give trouble. Iron plates in caustic soda are also rapidly affected, and even carbon soon crumbles away. Platinum seems to be the only reliable material, and this at its present price is too costly.

4.—Multiphase Alternate Motors.

Prof. Ferraris, in 1885, experimented with multiphase currents, and published his results in March, 1888, at Turin; and in May of the same year Tesla showed a rotary motor running with four wires; and Bradley, Haselwander, Wenstrom, Elihu Thomson, Dobrowolski, Brown, and others have introduced various modifications and improvements. The first practical demonstration was made by Dobrowolski and Brown with the Frankfort-Lauffen plant.

It should be noticed that in all rotary field motors and dynamos, it is not the current, but the resulting magnetism, that rotates; thus, if there are two circuits and four poles, the magnetism will be displaced 90° with each wave of current. In order to see this more fully, a simple case may be instanced. Fig. 1 is a four-pole diphase motor of elementary type, with a closed-circuit armature, having neither brushes nor commutator. There are two alternating exciting circuits, A A_1, and B B_1, in quadrature.

Suppose that A and A_1, be magnetised so as to cause lines of force to pass from A to A_1, through the armature, C. Then B and B_1 will be neutral, for there will be no current in them at this moment.

Next, the current A A_1 will gradually die away, and that in B B_1 will steadily rise in an equal and opposite ratio until the magnetic flux is from B to B_1, and A and A_1 are neutral.

This cycle will be repeated, but with one alteration—the current in A A_1 will rise to a negative maximum (assuming it to have been positive before), and the flux will be in the direction of A_1 to A; and in the next wave from B_1 to B. Carefully noting these changes, it is seen that the magnetic field has rotated once for a complete ~ in each of the circuits; and therefore the speed of the field rotation is $\frac{N}{n}$, where N is the number of ~ per second, and n is the number of

* Under the auspices of Messrs. Rothschild, who have generously voted the sum of 175,000 francs to enable them to carry out experiments with alternate motors on a commercial basis.

pairs of poles in one circuit. In the case referred to, since $n = 1$, the revolutions of the magnetic field will be the same as the number of ~. To make a diphase dynamo, it is necessary to replace the closed circuit armature by a suitable electro-magnet, having as many free poles as there are poles in one of the alternate current circuits,

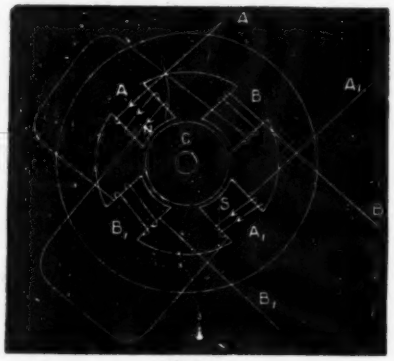


FIG. 1.

to excite this magnet with a continuous current, and to cause it to revolve.*

Then diphase periodic currents will be induced in the two circuits, A A_1, and B B_1, the phase difference between them being 90°.

Mathematically, the currents may be expressed thus:—

$$\text{That in A } A_1 = K \sin \alpha$$

$$\text{,, ,, B } B_1 = K \cos \alpha = K \sin \left(\alpha - \frac{\pi}{2}\right)$$

which shows the phase difference between the two currents. Now K is a constant for the particular machine, and α is a measure of the angular motion of the field. It will be seen that the current in A A_1 is a maximum when α is equal to $\frac{\pi}{2}$ and $\frac{3}{2}\pi$, and is zero when α is equal to 0 and π; the converse of this is the case with the current in B B_1.

Diphase systems require either four wires—*i.e.*, two for each circuit—or else the cross section of the common return must be increased by 1·4 times for the same loss. This is inconvenient, on account of both cost and complexity; but a far greater objection for large plants seems to be the apparently excessive variation in the field excitation; yet this view is strongly combatted by many competent engineers. Let fig. 2 be carefully examined.

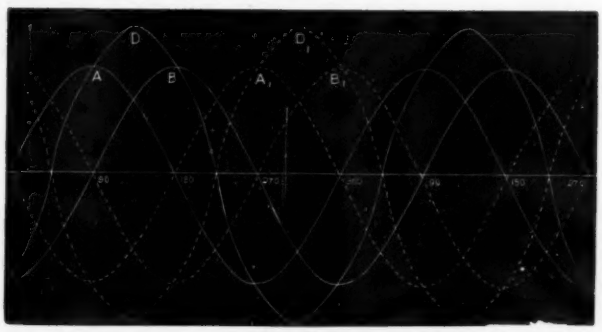


FIG. 2.

Curves A and B show the current fluctuations in the two circuits, and D that in the common return. The magnetic field will be caused by A and B alone, and, therefore, will be proportional to their sum at any instant. When A is a maximum, B is zero, and the induction at this moment is proportional to the current in A alone, and is equal to, say, C sin $\frac{\pi}{2}$ = C. When A and B are equal, as at 135° of field rotation, the induction is proportional to 2 C sin 135° = C 1·4. Thus the excitation varies between 1 and 1·4, the difference being nearly 30 per cent. of the highest value. The mean variation will be only about 15 per cent., it is true, but hysteresis and self-induction are proportional to the limiting values of the excitation, and eddy currents approximately to the squares of these differences.

Self-induction decreases the output for a given weight of material, and also by increasing the lag may largely augment the idle current for small loads.

To illustrate the fluctuation of the field excitation and consequent induction the sign of the negative curves in fig. 2 may be changed, and they may be plotted above the time line as if they were positive in value; or two fresh complete curves may be drawn, as shown in dotted lines and marked A_1 and B_1 in fig. 2, referring to the next two impulses of current immediately succeeding waves A and B.

Both these diagrams are justified by the consideration that each circuit in the motor contains at least two coils wound in opposite directions, and thus produces poles of different signs; and, therefore, the magnetism rotates continuously.

In fig. 3 the sign of the negative curves has been changed, and the excitation fluctuation is shown by the top curves, which may be regarded as having reference to one of the poles of the rotary field,

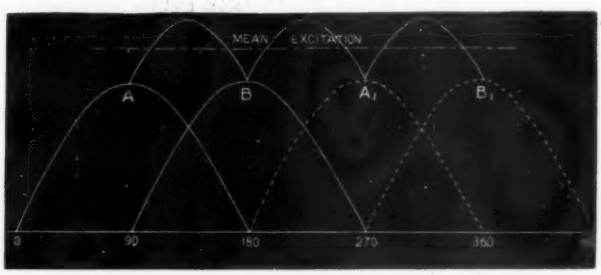


FIG. 3.

say the North pole; while with the double arrangement shown in fig. 2, since there are two sets of curves, one positive and the other negative, the variations of both poles are indicated. But as the fluctuations are sufficiently defined by the first method, the duplication involved in the latter seems to be unnecessary.

In the preceding considerations the armature reactions have been neglected. These are not easily estimated without some experimental acquaintance with the machine in question. But their effect will be a maximum at starting, and will decrease as the armature speed increases, and would be *nil* if the speed of armature and field coincided, *i.e.*, if the motor worked synchronously. The last condition is unattainable even with no load, for the friction of the bearings and air requires a certain amount of current in the armature to overcome it. Generally speaking, the armature reactions tend to weaken the resultant magnetic field and also to lessen the torque for a given current.

(To be continued.)

* Rotary magnetic field machines under certain conditions are reversible. See ELECTRICAL REVIEW, February 10th, 1893, in which an experiment is given showing the reversibility of a "three-phaser." Mr. Ernst Danielson, the experimenter and writer of the article, says that this depends on the fact "that when two single or multiphase machines are working synchronously, the current phase is in advance of the pressure of the generator, while it lags behind that in the motor." In practice, however, up to the present, it has been found advisable to excite the field magnets of alternate dynamos with direct currents. In the future some means may be devised by which multiphase generators may be made self-exciting; yet it is questionable whether this is worth the trouble of any complication.

Glasgow Philosophical Society.

AT the concluding meeting of the session of the Glasgow Philosophical Society a few weeks ago, Dr. J. T. Bottomley, F.R.S., gave three communications on subjects of public interest. Prof. Fergusson presided. Dr. Bottomley's first communication was on

VACUUM TUBES WITHOUT ELECTRODES.

At the outset he referred to the beautiful and well-known luminous effects that are commonly produced when an electric discharge passes through a vacuum. Generally, the electric discharge is introduced into a vacuum by means of electrodes of platinum and aluminium. The name of Prof. Crookes is associated with the investigation of the phenomena. In 1881, however, Dr. Bottomley showed to the Philosophical Society for the first time vacuum tubes which he had just then constructed, and which had no electrodes of any kind—that is, no conducting wires by means of which electricity can pass in or out through the non-conducting glass walls of the tube. Since that time some of the phenomena connected with such tubes had been examined by himself, Prof. Hittorf, and others; and last spring Mr. Tesla made a splendid display of such tubes at the Royal Institution, using an enormous power of gas engine and alternate current machines. On the present occasion Dr. Bottomley showed some of the tubes he had recently constructed, and the phenomena connected with them. The demonstration was conducted in a darkened room, and the tubes were excited by means of a secondary battery and induction coil. All the phenomena of striation and of attraction and repulsion of the discharge by currents outside the tubes were shown within these tubes, in spite of the fact that the electrodes did not exist. Tubes containing pieces of Iceland spar were also exhibited, the crystals being illuminated by the molecular bombardment of the minute traces of gases still existing in the vacuum driven by the electric discharge. It was shown that the phenomena are highly complicated with the mixed effects of the current induction and of electrostatic induction; and that the electrostatic disturbance of the vacuum has not been sufficiently taken into account in attempts to explain this phenomena. Dr. Bottomley expressed his indebtedness to Mr. Otto Müller, of 175, West George Street, Glasgow, whose unsurpassed skill in glass blowing had been invaluable to him. Dr. Bottomley showed a beautiful collection of vacuum tubes with electrodes, lent for the occasion by Mr. Müller. The audience followed the demonstration with much interest.

PHOTOGRAPHING BULLETS.

The second paper Dr. Bottomley contributed was on "Some Results

of Instantaneous Photography," in the course of which he showed and explained many interesting photographs of flying bullets, for which he was indebted to his friend Prof. Boys, of the Royal College of Science, South Kensington. He explained that the photographs were taken by sparks, and the first plate he submitted was to show the duration of such sparks. By an ingenious experiment Prof. Boys showed that the duration of a spark from a Leyden jar under certain pre-arranged conditions was about one-twentieth of a millionth of a second. It was a spark of this kind which was used for obtaining the photographs exhibited. He then proceeded to explain the method of photographing the bullets. The bullet was photographed, he said, immediately on leaving the rifle. On striking a pair of wires in its course, an electric circuit was closed which caused the electric spark. The process, he said, was originally due to Prof. Mach, but had been greatly simplified by Prof. Boys. He first exhibited a photograph of a bullet discharged from a Martini-Henry rifle, going at a rate of 1,250 feet per second. The entire shape of the bullet was seen sharply depicted; and around it were established remarkable phenomena of air-waves, which could be easily traced and examined. The waves of air compression which accompanied the bullet and the disturbance of the air in the wake of the bullet were plainly seen. The next photograph showed a bullet from a magazine rifle fired with the new smokeless powder, and going at the rate of more than 2,000 feet per second. The angle made by the air-waves with the line of the passage of the bullet was much sharper in the case of this bullet, which was swifter in speed. The inclination of the air-waves to the line of the passage of the bullet, he explained, showed the ratio between the velocity of sound—which was the speed at which the air-waves travelled—and the velocity of the bullet. The next plate related to the flight of an aluminium bullet, which was one-seventh part of the weight of a lead bullet, and therefore travelled at more than twice the velocity, which was shown by the inclination of the air-waves. The photograph of a bullet fired into a box filled with carbonic acid gas, in which the speed of the air waves is very much slower, was also exhibited. He next showed a discharge of shot from a sporting rifle which (when the investigation was completed), would probably be a revelation to the makers of shot guns. Prof. Boys is trying by means of photography to determine the conditions under which the shot scattered or kept together. Dr. Bottomley then showed a series of photographs of a bullet passing through a plate of glass. On first entering the glass, the splinters of glass are splashed back, and inside air-waves were shown. After the bullet has passed through, a different state of matters existed. The bullet sucked the splinters of glass through the hole it formed, and proceeded on its way with the rubbish clinging to it. After it has travelled a good distance further the rubbish gradually fell away from it, and could be seen following at a slower rate. The lecturer next showed three photographs recently sent over by Prof. Mach, of Germany. One related to a bullet in the air; the second was a thin jet of water, which to the eye appeared a continuous stream but in the photograph fell in drops; and the third related to air waves caused by an explosion at a centre. In the last the waves formed a complete sphere around the explosion, with an inside ring of rarefaction, and an outside ring of wave compression. Dr. Bottomley, in his third communication, exhibited and described a portable apparatus for

Testing the Insulation of Electric Light Wires.

He explained that this matter was of great interest and special importance here, now that the electric light was being introduced into Glasgow for lighting streets and dwelling houses. The instruments commonly designed and offered for testing the insulation of houses and mains had been found by Dr. Bottomley to be very unsatisfactory, defective, and costly, and he exhibited an improved apparatus for this purpose. He advocated very strongly the use of a very sensitive high resistance galvanometer with proportional graduation; and a direct comparison between the insulation of the installation to be tested with high resistances prepared for the purpose. The galvanometer shown was a modification of Lord Kelvin's well-known tangent arrangement used in his graded galvanometers. It was of such sensibility as to give a deflection of one scale division per millionth of an ampère—the magnitude of the division being such that one-tenth of a division was easily readable. The resistance of the galvanometer was 22,000 ohms. While testing with an electromotive force of 100 volts it was easy to determine exactly any insulation up to 150 megohms. The insulation expected in ordinary buildings might be from 10 megohms down to 200,000 ohms, according to the number of lights installed. Dr. Bottomley also exhibited resistances of a megohm (one million ohms), down to 100,000 ohms, and a portable bi-chromate battery constructed of minute test-tubes carefully insulated in paraffin, with small carbon rods and zinc wire. 144 such cells were shown in very moderate compass and weight. This supply was three or four times as much as would be required for ordinary business purposes. The apparatus was constructed by James White, of Cambridge Street, Glasgow.

At the conclusion Dr. Bottomley was awarded a hearty vote of thanks.

Société Internationale des Electriciens.

On the 3rd inst. the meeting of this society took place, with the new committee elected in April. M. L. Raymond occupied the president's chair; he announced the death of M. Frank Geraldy, and gave a short tribute to his memory.

M. Armagnat then read a paper on the Carpentier Apparatus for the Measurement of Resistances.

At first the accuracy of measuring instruments left much to be desired. Only bells with batteries were used. The tongue was at that time used as a galvanoscope. A large number of graduated instruments were then invented, the errors in which amounted to as much as 200 or 300 per cent. The Wheatstone bridge is not very practical nor very convenient, and it does not allow of high electromotive forces. The only really suitable apparatus is one from which direct readings can be taken. In 1881 the Carpentier firm brought out the proportional galvanometer formed of two bobbins at right angles, with a movable needle in the centre. With this apparatus, however, many errors occurred. It was difficult to obtain a magnetic field independent of the earth field. The errors might amount practically to 50 per cent. It was necessary to avoid placing it in the neighbourhood of magnetised objects. By rendering the bobbins movable and the needle fixed, we get a more constant field. It is thus that the ohmmeter of the Carpentier firm is constructed; a horse-shoe magnet, a fixed soft iron ring, two wire bobbins supported on pivots, and wires in the form of a spring to convey the current. One of the bobbins is placed in the circuit of the resistance to be measured, and the other in derivation. By this apparatus from 0 to 5 megohms can be measured. The current required for the measurements is furnished by a small hand dynamo giving 120 volts at 100 revolutions per minute. The armature is a Siemens drum divided into eight sections. We thus get a continuous current. The weight is eight kilogrammes, and the apparatus measures correctly within two to three per cent. The graduation of the apparatus is independent of the intensity, as it varies in both bobbins at the same time, and the ratio alone intervenes.

M. E. Desroziers then made a few remarks upon the distributions of motive power, and sketched out the programme of the Mulhouse competition. The most interesting case was that of the central steam stations, where it is possible to adopt more powerful units, and where we get great advantages as regards consumption of material, condensation and alimentation, reduction of hand labour, and consumption of coal. The jury adopted continuous currents only, because with alternating currents the motors do not start under a load, and because there is danger in the manipulation of polyphased currents, the charging of accumulators is impossible, the rendering is below that of continuous currents, and the regulation is delicate. M. Desroziers says that alternating currents have been objected to on the ground that they diminish the insulation. This objection is, however, without foundation, seeing that we have in Paris the Transmission Company working at 2,800 volts, and the Popp Company at 3,200 volts.

M. Desroziers then glanced at the various projects and described the steam engines, the interior of the works, and the modes of regulation adopted. The cost of establishment varied from 100 to 136 and 248 francs per H.P. rendered. M. Desroziers estimates that the supplementary expense for the transport is 5 francs per H.P. per kilometre. The cost by rail is one-third this amount. We cannot, therefore, hesitate to choose in preference, the transport of coal to a distance. In the Lauffen-Mulhouse scheme, the cost per H.P. rendered was 4,000 francs. For a transport of 50 km. at 3,000 volts, the cost of establishment was 1,130 francs per H.P. with a rendering of 50 per cent. Assuming the same rendering for a transport of 100 km. at 5,000 volts, the cost of establishment was 1,450 francs per H.P.

M. Hillairet then made a few observations on the utilisation of waterfalls. They can only be utilised if they are obtained at small cost. The total cost should not exceed 20 per cent. of the installation. To get good transmission to a distance of 3 kilometres, we must allow for a loss of 5 per cent. along the line, at 6 kilometres 10 per cent., at 15 kilometres 10 to 13 per cent., and at 20 kilometres 15 to 18 per cent.

NEW PATENTS—1893.

9,136. "An improved clutching device for use in electric arc lamps." E. J. Paterson and J. Foxcroft. Dated May 8th.

9,149. "Improvements in telephony." C. Adams-Randall. Dated May 8th.

9,171. "Improvements in electrically illuminated gun sights for use at night." H. de T. Phillips. Dated May 8th.

9,184. "An improvement in arc electric lamps." E. C. de Segundo. Dated May 8th.

9,204. "Improvements in electrical measuring and recording instruments." H. T. Harrison. Dated May 8th.

9,232. "Improvements in ship's telegraphs." E. Fletcher. Dated May 9th.

9,262. "Electric meters." O. Ericsson. Dated May 9th. (*Complete.*)

9,281. "New apparatus for counting telephonic conversations." R. H. Gould. Dated May 9th.

9,295. "An improved electrolytic apparatus." T. Craney. Dated May 9th. (*Complete.*)

9,296. "Improvements in apparatus for the electrolysis of salt." T. Craney. Dated May 9th. (*Complete.*)

9,297. "An improved electrolytic apparatus." T. Craney. Dated May 9th. (*Complete.*)

9,302. "Improvements in contacts for underground electric railways." W. Q. Prewitt. Dated May 9th. (*Complete.*)

9,304. "Improvements in electric lamps." A. J. Boult. (Communicated by J. Waring, United States.) Dated May 9th. (*Complete.*)

9,308. "Improvements in machines for equalising electrical currents without a current inverter." F. Vogel. Dated May 9th.

9,326. "Improvements in and relating to ships' telegraph dials." J. W. Ray. Dated May 10th.

9,358. "Improvements in connections for electric lighting and like purposes." G. Binswanger. Dated May 10th. (*Complete.*)

9,380. "Improvements relating to automatic breaking of current circuit for electric lamps or other devices." R. HADDAN. (Communicated by A. Reisinger, of Germany). Dated May 10th.

9,397. "Improved means for taking or transmitting power from electromotors." C. R. GARRARD and T. W. BLUMFIELD. Dated May 10th.

9,473. "An improved electrical device for curative purposes." G. RUSSELL. Dated May 11th.

9,478. "Improvements in insulators for electric wires." H. H. LAKE. (Communicated by Hartmann & Braun, Germany). Dated May 11th.

9,479. "Improvements in or connected with turnstiles and electric counters connected therewith." R. CHAVARRIA-CONTARDO. Dated May 11th. (*Complete.*)

9,486. "Improvements in stands for electromotors for dental and other purposes." W. GREENHALGH and S. W. CUTTRISS. Dated May 12th.

9,529. "Improvements in or relating to the distribution of electricity for electric lighting or other purposes." J. A. MCMULLEN. Dated May 12th.

9,552. "Improvements in or relating to microphones and telephones." T. PAETZOLD. Dated May 12th. (*Complete.*)

9,557. "Improvements in dynamo-electric machines and electric motors." H. N. PRENTICE. Dated May 12th.

9,627. "Improved means for supporting porcelain or other imitation candles on electric light fittings." H. FARADAY. Dated May 13th.

9,630. "Improvements in and relating to electric arc lamps." L. DE KOSTECKI and A. A. PICAL. Dated May 13th.

9,638. "Central office apparatus and circuits for telephone exchanges." E. J. HALL. Dated May 13th. [Date applied for under Patents Act, 1883, Section 103, October 13th, 1892, being date of application in United States.]

9,639. "Trunk line signalling apparatus and circuit for telephone exchanges." E. J. HALL. Dated May 13th. [Date applied for under Patents Acts, 1883, Section 103, October 13th, 1892, being date of application in United States].

9,640. "Electrical signalling apparatus and circuits." E. J. HALL and F. A. PICKERNELL. Dated May 13th. [Date applied for under Patents Act, 1883, Section 103, October 13th, 1892, being date of application in United States].

9,641. "Busy signal for telephone circuits." E. J. HALL and F. A. PICKERNELL. Dated May 13th. [Date applied for under Patents Act, 1883, Section 103, October 13th, 1892, being date of application in United States].

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

15,075. "An improved portable electric lamp." R. THOMPSON and H. S. PYNE. Dated September 7th. Claims:—1. The use of the depolarising liquor as described in connection with carbon elements in the porous vessels of two fluid batteries. 2. The use of two or more carbons each in its own porous vessel in the same cell of a two-fluid primary battery. 3. The arrangement as described by which any carbon can be brought into or taken out of circuit as described, and, 4. The general combination of the two-fluid battery and lamp as described.

15,705. "Electric signalling on railways to trains in motion or otherwise." J. WATKINSON and G. PRINCE. Dated September 16th. By this system the locomotive, when travelling, brings an electric current collector to brush over plates located by the side of a distant semaphore post, and by so doing gives the engineman a signal upon the indicator. If the signal given be danger, the engineman gets his engine under control, so as to stop upon plates located by the side of home semaphore post, and then wait until he gets a clear signal to go on.

16,076. "Automatic coin freed telephonic system." J. WRATITSCH and S. GERGACSEVICS. Dated September 22nd. Has for its object to considerably reduce the cost of working as well as the staff in charge of telephonic apparatus, by erecting public telephonic stations, and to further enable everyone to use these stations at any time during the day and night without requiring extraneous help, and without being possessed of special knowledge, the station operating automatically. 1 claim.

16,572. "Improvements in dynamo-electric machines and motors." W. B. SAYERS. Dated September 29th. Instead of making the connections between the armature winding and commutator sections in the ordinary manner, the inventor winds these connections around the armature core in such a direction and in such a position relatively to the position of the armature coils to which they are connected, that the E.M.Fs. induced in them, and the armature coil which forms a connection through the two commutator coils concerned at any time shall tend to neutralise one another, if one of the said commutator coils is under the pole piece, and the other not, at the moment when the brush connects the two sections of the commutator. The winding is so designed that the resultant E.M.F. shall be just sufficient to reverse the current in the armature coil and to reduce the current in the commutator coil to zero at the moment when it is leaving the brush. By this means there is obtained a sparkless break. 3 claims.

16,934. "Improvements in secondary or storage batteries." H. H. LAKE. (Communicated from abroad by P. Kennedy and C. J. Diss, both of Brooklyn, New York.) Dated October 6th. The inventor provides a structure for holding the active material of a storage battery which is composed of material that is practically a non-conductor of electricity, and he places the said structure in due relation with a conductor of electricity arranged in contact with the said active material. The active material may be red lead or any other suitable material. 8 claims.

16,938. "Improvements in secondary or storage batteries." H. H. LAKE. (Communicated from abroad by P. Kennedy and C. J. Diss, both of Brooklyn, New York.) Dated October 6th. The object of the present invention is to provide a non-conducting structure for holding the active material, which will be strong, light, durable, easily and cheaply manufactured, and not liable to warp out of shape when applied to use. To this end the said invention comprises a structure composed of a non-conducting material, such as shellac, capable, in a plastic condition, of being incorporated with other substances and of subsequently coming, in such incorporated state, to a condition sufficiently hard and rigid to retain its shape, in combination with a non-conducting mineral substance, the particles, granules, or fibres of which are united in the mass by the originally plastic material incorporated therewith.

18,162. "Improvements in the insulation of electrical lamp and other fittings." H. C. GOVER. Dated October 22nd. The inventor coats the metallic parts with enamel of a vitreous non-conducting character of any known kind, capable of standing considerable changes of temperature without cracking or scaling. 1 claim.

18,451. "Improvements in telephonic switching apparatus." A. R. BENNETT. Dated October 27th. Each connecting cord for metallic circuit switching necessarily consists of two insulated conductors. From each conductor of such a cord, preferably from its centre, the inventor leads a branch wire or conductor to earth through a resistance which may conveniently consist of a coil of insulated wire wound on a bobbin. Each operator is provided with a testing apparatus consisting of a flexible conducting cord tipped with metal, which cord is permanently connected to earth through a source of electricity, such as a voltaic battery or magneto generator, and through an instrument capable of indicating visibly or audibly when a current passes through it. To test, the operator applies the metal tip of her testing cord to the metal socket of the metallic circuit which is before her on her section of the switchboard. If there is no connecting cord in a socket of the same metallic circuit on any other section, the indicating instrument will not be affected since the current from the source of electricity contained in the circuit of the cord cannot find an outlet through the metallic circuit which is everywhere insulated from the earth. The absence of a signal will show that the metallic circuit wanted is not engaged at any other section, and the operator may accordingly connect it on hers. But if a connecting cord is in a socket on any other section, the indicating instrument will reveal a current the moment the tip of the testing cord is applied to the socket, since the battery current will now find an outlet to earth through one of the branches to earth from the connecting cord that may so be in. The operator will then know that the metallic circuit wanted is engaged, and must not be connected on her section.

19,778. "Improvements in electric lighting apparatus." R. A. DAWBARN. Dated November 14th. According to one arrangement, there is an electro-magnet normally in circuit with one of two incandescence lamps. This electro-magnet when energised lifts an armature, thereby interrupting the path of the current through the second lamp in parallel with the first. Conversely, when the current ceases to flow through the first lamp from any cause, such as the breaking of its filament, the electro-magnet will cease to be energised, and consequently the armature will be released and dropped upon a contact whereby the circuit will be established through the second lamp. 1 claim.

CORRESPONDENCE.

Electric Heating.

Mr. Dowsing is an admirable partisan, and has supported the claims of electric cooking as none but he could do. At the same time there are matters in his letter which afford food for thought to those whose views of electro-culinary operations are more concerned with efficiencies and possibilities than with the domestic virtues which have so well and ably been championed for the knicknacks. Mr. Dowsing states: "To boil a quart of water requires about 3½ ampères for 10 minutes." "For instance, taking the usual pressure of 100 volts a unit will give us 10 ampères for one hour." Let us see if this roseate view can be substantiated.

To do this we will assume nothing, but base our calculations upon the data given by definitions of the units.

$$1 \text{ B.O.T. unit} = 1{,}000 \text{ watt-hours} = \frac{1.000}{746} \text{ H.P. hours} =$$

$$\frac{1{,}000}{746} \times (33{,}000 \times 60) \text{ foot-pounds} = 2{,}654{,}000 \text{ foot-}$$

pounds approximately. The value worked out comes to 2,654,100 or 2,654,280, depending upon the number of decimals used. Now by Joule's equivalent 772 foot-pounds equal 1 B.T.U., therefore 2,654,000 ÷ 772 = B.T.U. per unit. The numerical value is about 3,438 B.T.U. per B.O.T. unit. This is at the rate of 3·5 B.T.U. per watt-hour. Now to heat two pints or one quart of water from say 15° C. to 100° C., or 60° F. to 212° F., requires a rise of temperature of 150° F., while the weight of water is 2½ lbs. A gallon weighs 10 lbs., and

A pint of water
Weighs a pound and a quarter.

Thus 2½ lbs. × 150° = 375 B.T.U. (It is near enough to take the heat required by one pound degree as a B.T.U., for although the coefficient of expansion will render this not strictly so, it is accurate enough for our present purposes.) Now, Mr. Dowsing allows for the work:—3½ ampères at 100 volts = 350 watts, which, for 10 minutes is:

$$350 \div \frac{60}{10} = \text{less than 60 watt-hours.}$$

We have seen that to get B.T.U. we multiply by 3·5, so: 60 × 3·5 = 210 B.T.U. Therefore:—

Mr. Dowsing allows	to do the net work of
210 B.T.U.	375 B.T.U.

Surely Messrs. Crompton's heaters have not yet been made to give an efficiency of 160 per cent.?

Taking it another way, by tests it has been found possible to raise a pint of water from 60° F. to 212° F. by expending 60 watt-hours, this being an efficiency of over 90 per cent. of total heat.

1¼ lbs. of water × 150° F. = 187 B.T.U. required.
60 watt-hours × 3½ = 210 B.T.U. supplied.

An electric kettle heater of one quart or two pints capacity as actually made, requires 5 ampères at 100 volts for 16 or 18 minutes; *i.e.*, 500 watts for ⅓ hour = ⅙ unit, which at St. Pancras, during the day, would cost ½d., or elsewhere more nearly 1d. for boiling one quart of tap water.

Let us hope the rest of the figures in Mr. Dowsing's letter are a little nearer what the law of conservation of energy requires them to be, than the example we have rather roughly handled.

"Diogenes The Second."

May 22nd, 1893.

Paralleling of Alternators.

In your article on the Leeds Central Station, which deals so fully with the system of supply under the Hammond-Lowric-Hall patents, you state that these gentlemen claim "that it is only in the works laid down by them in England that parallel running is regularly practised." Now it is clear that your readers will be liable to assume that this is so; but I should like to correct the statement somewhat. The West Brompton station began, I believe, to run parallel as a regular everyday occurrence very shortly after Mr. Albert Gay had come up from Brighton station to take up the management there. Thus it was one of the earliest to go in for this practice, although about the same time Bournemouth was compelled to adopt the same course. In the latter case, at first, only one trunk main existed from Bournevalley to the town, and when the load increased beyond the capacity of the largest single unit, it was imperative to buss bar the working machines.

About this time last year I was much interested in the question, being engaged in laying down a station which, from its special circumstances, was compelled to adopt alternating plant, capable of parallel running, and after looking closely into what had been done, I found that stations were at work which were running parallel as a general practice with the following machines: Ferranti, Lowrie-Hall, and Mordey-Victoria.

I embodied some of the facts I had unearthed in a letter to the *Electrician* about the same time, of which a copy was, if I remember rightly, sent you, and as I had unfortunately omitted West Brompton, Mr. Albert Gay was good enough to call my attention to what was being done there in a letter to *Lightning* a week or so later.

As to facts, I question if, by the time stations now in hand are running, and we examine the conditions of supply, it will be found that one-third of the alternating systems are running on separate circuits.

Certainly the City of London Company is one which "parallels" nightly, so that while giving Messrs. Lowrie and Hall their due, it is unfair not to award a meed of praise to such pioneers of parallel running as Mr. J. S. Raworth and Mr. W. M. Mordey, while if one took the trouble, it would no doubt be found that Mr. Ferranti, at Deptford, was as early in the field as anyone.

Although this system of running affords a resultant economy in excess of "districting" or non-parallel working, its advantages are not so great, in the majority of cases, as to put the latter completely out of the field.

At Newcastle, Mr. R. C. Jackson has shown what can be done without such a help, and he has expressed his opinion that "advantageous as it is, alternating converter systems of lighting can be run on a commercial and satisfactory financial basis, even where paralleling is not adopted."

Charles H. Yeaman.

May 20th, 1893.

Railway Train Lighting.

Mr. E. J. Houghton's explanation on this subject in your issue of the 12th inst. is so *unsatisfactory*, *misleading*, and *incorrect*, that I feel compelled to solicit the favour of your affording the space to state the *following facts*, viz.:

On December 10th, 1881, I took out a patent for my invention for utilising the motive power of the *axles of railway trains* for driving dynamos (preferably that of the guard's van) to charge accumulators, and from them to light the whole train.

There was no "additional line of rails for the purpose of working the dynamo," and no mention of "the permanent employment of an attendant in the brake van to look after the dynamo." That is an *invention* of Mr. Houghton's, and certainly not one of mine.

Mr. J. Knight, then the general manager of the London and Brighton Railway Company, who I know well, requested me to submit my plans and specification through him to his company, which I did on his assurance verbally, and soon afterwards by his *official letters*, that "*No advantage or use whatever* should be taken of my plans and specification *to my prejudice*." Mr. Houghton, as the electrician of the company, also *wrote to me officially to precisely the same effect* by direction of Mr. Knight. I presume Mr. Houghton has *now* the same access to the company's letter books as he had then *in 1882*, and I challenge him to contradict by statements of facts.

On May 23rd, 1883, the late Mr. William Stroudley (locomotive and carriage superintendent) and Mr. E. J. Houghton (electrician of the company) obtained a patent on *precisely* the same lines of my plans and patent referred to, *after* the written assurance of themselves and that of the general manager of the company, upon which their first train was fitted up.

I venture to appeal to you, Sir, to examine the two patents, viz., that of mine dated December 12th, 1881, and that of Stroudley and Houghton, dated May 23rd, 1883, and to say wherein lies the difference, and with the knowledge Mr. Houghton has of the facts, whether his explanation is *fair* or *not*.

J. Evelyn-Llardet.

[Perhaps both gentlemen will send us their specifications? —Eds. Elec. Rev.]

Facts and Figures on Electrolytic Chlorine and Soda.

Our attention has been called to an article headed "Facts and Figures on Electrolytic Chlorine and Soda," by Emile Andreoli, in your issue of May 12th, 1893.

Will you allow us to state that the "Mr. Tate, F.C.S., Analytical and Technical Chemist, of Liverpool," whose report is referred to in this contribution, is not associated with our firm.

We ask you to kindly make this explanation, as we have had several enquiries, *re* the Richardson-Holland process, from gentlemen who have assumed that the Mr. Tate who has reported on this process is our Mr. Frank Tate.

A. Norman Tate & Co.

Liverpool, *May 24th*, 1893.